to provide guidance as to whether, for example, statistical relationships based on historical observations of O_3 and temperature will serve as accurate approximations of the effects of climate change in a given region. Other applications might include evaluating the potential for unintended consequences of a particular policy choice, e.g., whether tree plantations for carbon sequestration might harm air quality in a given region in the face of future climate change.

In addition, these findings highlight a number of areas where further research is needed:

1. First, as has been emphasized throughout, an improved understanding of how well models simulate the large-scale circulation patterns that are important for air quality is needed. This issue was being considered at least as early as 1991, when the NRC pointed out that whether a GCM simulated a persistent high or low pressure pattern over a given region had the potential to counteract any increase in O_3 associated with warmer temperatures, through changes in other meteorological drivers (NRC, 1991). The NRC also pointed out in this report that GCMs do not in general simulate the same shifts in pressure patterns in response to increases in greenhouse gases. As discussed above in Section 3.4, these kinds of disagreements among models persist today.
2. As a related point, there is a need for an improved understanding of how well RCMs can downscale changes in these GCM-simulated circulation patterns, as well as a need for more insight into the sensitivity of these downscaled regional simulations to model parameterizations, including convection schemes, but also expanding to PBL, radiative transfer, microphysics, and land-surface schemes.
3. Recalling the discussion surrounding Box 3-1, a critical component of addressing points 1 and 2 above will be extending efforts, initiated in this first phase of the assessment, to evaluate the GCM- and RCM-based systems for the meteorological variables, and especially the temporal statistics of the meteorology, most appropriate for air quality: for example, long-term average changes in the frequency, duration, and intensity of stagnation episodes driven by synoptic-scale variability. This will need to include outputting and analyzing the required quantities, at the required temporal frequency, from the models, as well as further analyses of historical observational data.
4. Development and refinement of techniques for systematically exploring the effects of the modeling uncertainties are also needed, including ensemble methods, techniques for blending ensemble approaches with dynamical downscaling, and reduced form models.
5. An issue raised in a small subset of the results discussed in this section is whether or not the possible future extension of the O_3 season into the spring and fall is robust across more simulations. Additional simulations that go beyond summertime are needed to address this.
6. Another issue arising from a small subset of the results is the question of interannual variability. Particularly in the regional modeling results, to date there is disparity in the number of years simulated across the different groups. Moving forward, more precise quantification of the magnitude of mean future O_3 changes relative to interannual variability, as well as the potential for future increases or decreases in interannual variability itself, is needed.

Moving beyond meteorology, the results to date also suggest important gaps in our understanding of issues related to chemistry and emissions:

1. More research is needed into the links between climate, biogenic emissions, and O_3. The results presented here highlight the importance of correctly representing isoprene nitrate chemistry in models to accurately capture the response of O_3 to changes in emissions. In addition, there are other uncertainties in chemical mechanisms with the potential to influence climate change-air quality impacts that require further study.
2. Improving biogenic emissions inventories and process models of the response of biogenic emissions to climate and atmospheric composition changes should also be a priority.
3. Changes in deposition velocity as a function of the impact of changing CO_2 concentrations on stomatal conductance could also be incorporated into the modeling systems.
4. An overarching issue that has not been fully addressed to date is whether or not the overall O_3 chemical regime change as a function of climate change, and/or global atmospheric composition change (e.g., as a function of changing concentrations of CH_4 and other species).
5. As already discussed, while some of the groups have also carried out simulations of PM, in addition to O_3, the focus in this section is only on the O_3 results. Our understanding of how to represent PM chemistry in modeling systems is more limited, and there are a number of additional complexities surrounding PM, including the fact that it consists of multiple species, and that precipitation is a more important primary meteorological driver for PM than for O_3, an issue because the uncertainties in modeling precipitation are much greater than in modeling, for example, temperature. Much additional research is needed on simulating the potential impacts of climate change on PM. Brief summaries of the ongoing work on PM under this assessment, as well as on emissions and chemistry issues, is provided next, in Section 4.

Furthermore, there are a wide range of issues related to anthropogenic emissions of precursor pollutants that will become important as the assessment moves into its next phase. These include the impacts of changes, on future emissions in the United States (and worldwide), in:

- Energy use
- Land use
- Agricultural practices
- Transportation patterns
- Demographics
- Technology

Building on the modeling experiments discussed here, one major consideration is that much additional work is needed to construct emissions scenarios that are realistic and internally self-consistent across both greenhouse gases and precursor pollutants. These and other issues will feature prominently in Phase II of the assessment, and they are previewed in Section 4.

Finally, there are a number of issues for the air quality management community to consider, related to the potential for scientific research to provide improved decision support. These include how best to inform the scientific community about the specific air quality metrics to focus on in research that would best inform management activities, as well as how best to address mismatches between the timescales of air quality management and long-term global climate change.

4 FUTURE DIRECTIONS

4.1 PHASE II OF THE GLOBAL CHANGE AND AIR QUALITY ASSESSMENT

As outlined in Section 2, Phase II of the assessment program requires a transition from climate-only studies to an evaluation of the integrated effects of changes in climate and changes in anthropogenic air pollutant emissions. Simplistic assumptions about future U.S. emissions are of limited usefulness for evaluating the possible range of climate change impacts on air quality at scales that are of interest for planning and management. Therefore, EPA ORD has initiated several projects that are developing new methods and modeling tools for creating regional-scale emissions projections for the United States. These projects recognize that the important drivers of future changes in air pollutant emissions are linked. For example, economic factors influence population migration which, in turn, affects land use, thereby affecting air pollutant emissions via choices in transportation modalities. To realistically represent the feedbacks among the drivers of air pollutant emissions, modeling systems must be developed that capture these links between underlying processes.

Phase II of the air quality assessment will also build upon the insights gained in Phase I from the efforts of the contributing research teams in producing climate change-only air quality simulations, including the effects of particular modeling choices. This section, therefore, begins by highlighting efforts underway to improve the climate-air quality modeling systems, and planned efforts to develop efficient approaches for evaluating the impact of uncertainties on model outputs. An overview of the projects focused on devising modeling tools to capture the processes governing the underlying drivers of air pollutant emissions, and the links between them, follows. Air pollutant emissions scenarios will eventually be shared with the climate-air quality modeling teams, who will, in turn, simulate the integrated effects of climate and emissions changes on regional U.S. air quality.

4.2 EXTENDING THE MODELING SYSTEMS

Section 3 concluded with a discussion of modeling uncertainties and research needs to be addressed. Ongoing and upcoming activities designed to achieve these improvements and needed advances in modeling capability are discussed in the following subsections.

4.2.1 Exploring Modeling Uncertainties

Ensemble modeling techniques are being applied to more fully explore the effects on model outputs of uncertainties in the global-to-regional climate and air quality modeling systems. This involves blending multiple alternative GCMs, RCMs, and RAQMs with multiple

emissions scenarios and model physical parameterizations (including both PBL and convection schemes). In addition, some of the work will explore the use of Bayesian weighting of ensemble members based on their skill in representing both observed climate and air quality, as a means of reducing the number of ensemble members required for capturing the probable range of future climate changes. Adding new GCMs, RCMs, and RAQMs to the suite used in Phase I is also an important element of this work.

Several modeling teams plan to evaluate potential changes in the length and timing of annual O_3 seasons under a changed climate. To better capture and characterize changes in interannual variability in different climate regimes, simulations of additional present-day and future years with the global-to-regional modeling systems are also planned.

Finally, the groups discussed in Section 3 that carried out global scale-only simulations are in the process of conducting comparable studies using downscaled global-to-regional modeling systems. The application of these new systems to simulations of future regional climate and air quality will also expand the range of models, scenarios, and methodologies in the assessment. Added to the results obtained to date, these new simulations have the potential to increase the level of confidence in, and/or add nuance to, key conclusions made in this report.

4.2.2 Additional Model Development

Substantial uncertainty remains in the modeling of current biogenic VOC emissions. EPA ORD is currently supporting studies to better define the processes governing biogenic emissions to improve their representation in regional air quality modeling systems. These studies include work to identify and quantify species-dependent emissions sensitivities to temperature and other meteorological variables, to changes in forest composition in response to changing climate, and to changes in ambient CO_2 concentrations, based on observations and biochemical modeling.

The accumulating body of new scientific insights is being used to design biogenic emissions models with greater process realism. These models are also being extended to include complementary capabilities, such as dynamic vegetation sub-models to capture the two-way coupling between land cover and climate. These improvements will assist in increasing our understanding of the potential role of biogenic emissions changes in global change-related impacts on air quality.

The importance of feedbacks between climate change and regional air quality is not presently well understood. Should climate change produce significant changes in aerosol chemistry and composition, or substantial changes in tropospheric O_3, those perturbations could feed back onto the Earth's radiation budget, possibly driving further changes in climate. Other research efforts within the assessment program include an investigation of the importance of

these two-way feedbacks between climate change and air quality. To explore this question, NERL is expanding the pollutant chemistry represented in the Weather Research and Forecast Model with Chemistry (WRF/Chem). Simultaneously, an extramural effort funded by the STAR program is directly linking WRF with the CMAQ model in a combined WRF-CMAQ system. Both will be applied in studies of future climate and air quality. Downscaling GCM simulations of future climate using WRF/Chem and WRF-CMAQ will allow for the assessment of possible long-term impacts of global change on regional air quality while accounting for feedbacks between meteorology, air quality, and radiation in a unified modeling framework.

4.2.3 Additional Pollutants—PM

Some of the groups whose O_3 results are featured in Section 3 have also carried out simulations of PM. Because of the additional complexities and uncertainties associated with PM and its response to climate change, these results were not incorporated into the synthesis. However, a few preliminary results suggest that

- Globally, PM generally decreases as a result of simulated climate change (with anthropogenic emissions held constant), due to increased atmospheric humidity and/or increased precipitation;
- Regionally, simulated climate change produces both increases and decreases in PM (on the order of a few percent) in 2050, depending on the region of the United States, with the largest increases in the Midwest and Northeast;
- The responses of the individual species that make up net PM (e.g., sulfate, nitrate, ammonium, black carbon, organic carbon, etc.) to climate change are highly variable, depending on the chemistry and transport characteristics of each species;
- Key uncertainties to which simulated PM is sensitive include model precipitation, model aerosol chemistry, aerosol-cloud interactions, volatilization of semi-volatile PM species, such as nitrate and secondary organic aerosol (SOA), and assumed future air pollution emissions.

Building on these findings, work underway, both within EPA and funded through the STAR program, is continuing to explore the impacts of climate and emissions changes on PM in coupled climate and air quality modeling systems. Efforts to improve the relevant aerosol chemistry in these models, as well as to introduce the capability of two-way coupling between chemistry and meteorology (as noted above) are also underway. In addition, substantial work is being done outside the EPA sphere that is expected to contribute knowledge and techniques as the assessment moves forward.

4.2.4 Additional Pollutants—Mercury

Some of the modeling groups already highlighted in this report, in conjunction with several new groups, will also be extending our understanding of the impact of global change on air pollution to mercury (Hg). Climate change can potentially impact a number of atmospheric processes that help determine the fate of Hg, including heterogeneous oxidation of gas-phase Hg, dry deposition of elemental, reactive gas-phase and particulate Hg, and Hg chemistry in the presence of fog, clouds, and photochemical smog.

These groups will use both models and observational datasets to explore Hg chemistry and transport as a function of climate and emissions changes. The focus will be on present and future Hg distribution for the United States as a whole, as well as for particular regions, e.g., the Great Lakes, Florida. In addition, this work will be aimed at improving the Hg chemistry in the linked climate and air quality modeling systems by incorporating additional reactions and refining existing representations.

4.3 COMBINED IMPACTS OF CLIMATE AND EMISSIONS CHANGES: PRELIMINARY WORK

Several of the modeling teams that produced the simulations discussed in Section 3 also conducted preliminary evaluations of the combined effects of changes in anthropogenic air pollutant precursor emissions and changes in climate on regional U.S. quality. The general approach taken was to assume that, rather than remaining constant at the NEI 1999−2000 levels, future U.S. emissions of pollutant precursors, i.e., NO_x, SO_2, VOCs, and CO, scaled in ways that were consistent with the IPCC SRES scenarios.

The major findings that emerged from these sensitivity studies are as follows: First, that the combined effects of climate and anthropogenic precursor emissions changes are much more sensitive to the assumptions about future emissions trajectories than differences in simulated climate across models and groups. For example, simple scaling of future emissions to match the gross assumptions of the IPCC A1b or B1 SRES scenario resulted in substantial reductions in NO_x emissions, with corresponding reductions in simulated future O_3 that dominated any increases associated with climate change. In contrast, using future emissions consistent with the weaker pollutant control assumptions in the “dirtier” A2 or A1Fi scenarios tended to result in climate and emissions producing changes of comparable magnitudes. Second, the effects of climate and emissions changes are not, in general, additive. In other words, the degree of “climate penalty” on air quality is itself highly dependent on the emissions levels.

Therefore, these results highlight the need for additional work to develop more sophisticated, regionally detailed scenarios of U.S. anthropogenic precursor pollutants that account for population, economic, energy, and transportation changes, along with work to

improve the representation of natural emissions sensitive to climate and land-use changes. These efforts are highlighted in the next sub-section.

4.4 MODELING THE DRIVERS OF AIR POLLUTANT EMISSIONS

Human activities, such as population growth and migration, economic growth, land use, and technology change are key drivers affecting emissions. Changes in human activity patterns impact pollutant emissions across the globe, and, combined with global scale circulation patterns, influence the long-range transport of air pollution into the United States.

There is a gap in our understanding of how these factors will interact to influence air quality at urban and regional scales in the United States. In addition, while human activities generate the largest share of the U.S. air pollutant emissions burden, biogenic and wildfire emissions also contribute to the degradation of regional-scale air quality. The vegetation composition and biomass density of forest ecosystems help determine both the emissions of biogenic VOCs and the intensity and frequency of wildfires. These properties are sensitive, to varying degrees, to changing climate and to local and regional development. Future progress will require integrating population growth and land-use models with economic forecasts, technology models, travel demand models, mobile source models, and forest composition and wildfire process models to create emissions modeling systems that can be used to blend comprehensive scenarios of future air pollution emissions with those of future climate and meteorology changes (Figure 4-1).

As described in Section 2, evaluating the combined air quality impacts of changing anthropogenic emissions levels, changing biogenic and wildfire emissions levels, and changing climate is a critical goal of Phase II of the air quality assessment effort. To accomplish this, the assessment program has undertaken a significant research effort to develop and/or apply the necessary emissions projection tools. The following sub-sections highlight efforts underway to investigate the critical processes leading to pollutant emissions changes and to incorporate this information into modeling tools capable of realistically simulating long-term emissions changes.

A growing U.S. population can be expected to lead to increased energy and transportation service demands, potentially leading to increased pollutant emissions, depending on control strategies implemented. In addition, internal migration of the U.S. population could redistribute pollutant emissions geographically.

The Cohort-Component methodology[17] is being used to develop a range of scenarios of future U.S. population. These scenarios build on the Census Bureau's population projections, systematically incorporating assumptions to express the differences captured in the IPCC SRES

[17] For example, see http://www.census.gov/population/www/projections/aboutproj.html.

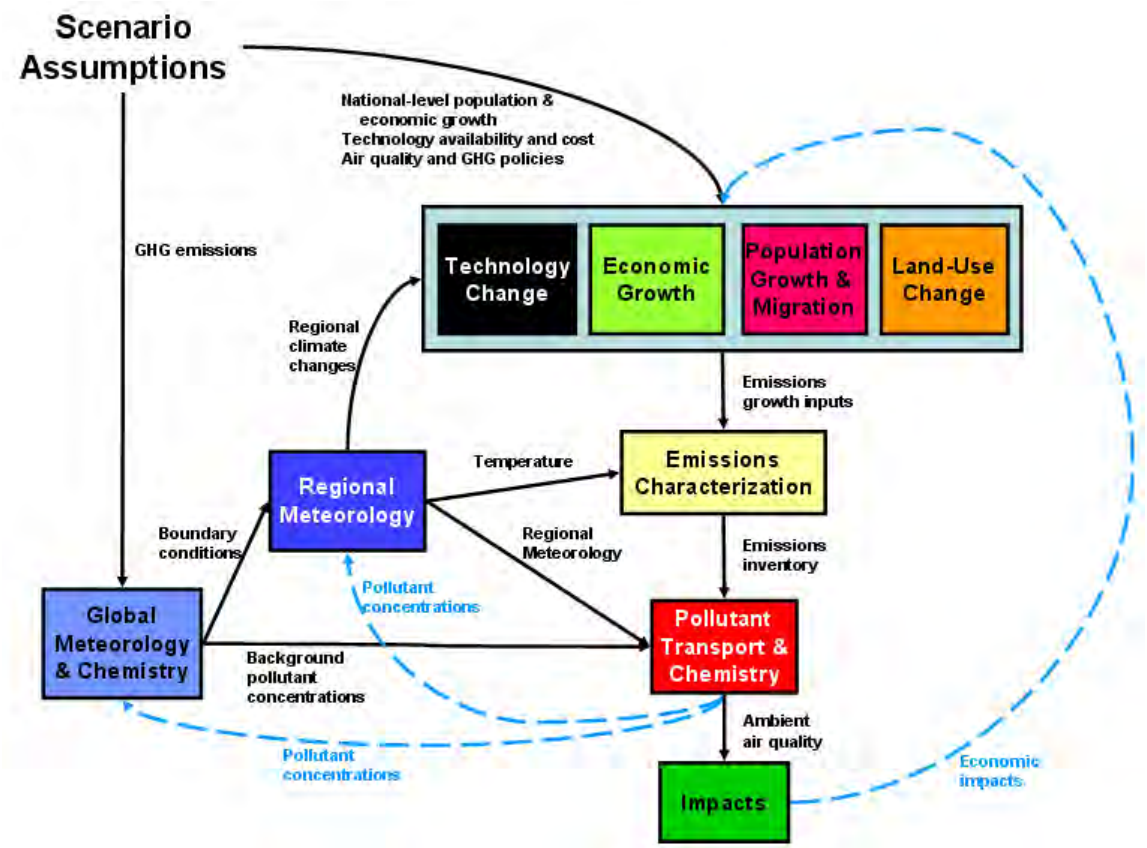

Figure 4-1. Integrated system of future climate, meteorology, and emissions scenarios. Population growth, migration, and land use. The dashed blue lines represent feedbacks.

storylines. The migration component of the demographic model uses a regression-based "gravity" model that depends on the functional connectivity of each county to all others and amenity values to estimate production and attraction values for domestic migration. This effort is exploring the wide range of assumptions at national, state, and local scales in the United States that are consistent with the general SRES storylines.

Future development patterns will result in changes in both the quantity and location of pollutant emissions. The demographic-migration model described above is being coupled with a spatial allocation-type land-use model to develop urban and exurban growth projections consistent with the SRES storylines. The potential of these land-use scenarios for spatially allocating emission sources is under investigation.

4.4.1 Economic Growth and Technology Choices

Absent additional air pollution controls and/or improvements in technologies, economic growth would be expected to increase emissions. Other trends, like further transformation from a manufacturing-based to a service-based economy, can also lead to changes in domestic emissions. A range of plausible economic scenarios to capture these factors is needed as part of an integrated evaluation of human-driven change in future emissions. Several models have been employed by OAR in policymaking, and the EPA's Global Change Research Program is planning to evaluate them (and others) for application in the Phase II assessment effort.

Changes in future anthropogenic emissions cannot be understood apart from the development, deployment, and use of energy and transportation technologies. To assist in defining those relationships, a Market Allocation (MARKAL) energy-systems modeling framework has been developed to examine the most emission-intensive sectors of the U.S. economy: transportation and electric power production. MARKAL maps the energy economy from primary energy sources, through their refining and transformation processes, to the point at which a variety of technologies (e.g., classes of light-duty personal vehicles, heat pumps, or gas furnaces) service end-use energy demands (e.g., projected vehicle miles traveled, space heating). A large linear programming model, MARKAL determines the least-cost pattern of technology investment and use required to meet specified demands, and then calculates the resulting criteria pollutant and greenhouse gas emissions. Preliminary scenarios of potential future emissions and emissions growth factors for energy system technologies, such as combustion technologies in the electricity generation, transportation, industrial, residential, and commercial sectors, have been generated for the United States. Particular attention has been paid to alternative-fuel vehicles (e.g., ethanol-gasoline, plug-in gasoline-electric hybrids, hydrogen fuel cell) and analyses to date show that different technology development and penetration scenarios can have greatly differing emissions consequences.

Research has also been conducted on the response of electricity consumption to warming from climate change, capacity siting and dispatch decisions, and characterization of emerging energy generation technologies in terms of cost and cost projections and learning parameters. This modeling system has been used to analyze the effect of climate change upon the temporal and spatial distributions of NO_x emissions in the Mid-Atlantic and Midwest power markets. An additional study investigates air quality consequences from the broad adoption of ethanol-gasoline, plug-in gasoline-electric hybrids, and wind-electrolysis-hydrogen fuel-cell vehicles. The consequence of this technology shift will be explored for Los Angeles, the Central Valley, and Atlanta over the next 50 years.

4.4.2 Land Use and Transportation

A critical and previously unexplored dimension in projecting air quality in response to human factors is the spatial distribution of the emissions projected to result from land-use and transportation choices. Several studies of the connection between socioeconomic forces, land-use planning and development patterns, policy design, and future air quality are underway as part of the assessment's research program. Specific studies include

- In Washington DC, development and application of a flexible modeling framework to estimate long-term mobile sources emissions;
- In Chicago, an examination of the consequences of continued deindustrialization of U.S. manufacturing and its impact on the city's manufacturing-heavy metro area;
- In the Upper Midwest, a study of the air quality changes associated with a "smart growth" land-use and development policy over the next 25 to 50 years;
- In the San Joaquin Valley, CA, investigation of the effect on emissions from combined changes in economics, land-use, water constraints, transportation, and stationary sources;
- In the Charlotte, NC metro area, an examination of the influence of development patterns (e.g., transit oriented development, dense mixed-use development, development supportive of non-motorized transportation modes for non-work trips, neo-traditional suburbs, new urban core development, and redevelopment) on the spatial characteristics and quantity of emissions;
- In Austin, TX, a comparison of emissions, air quality, and exposures from an integrated transportation-land-use model with four urban growth scenarios developed through a regional "visioning" initiative known as Envision Central Texas;
- In the Puget Sound region, a project to integrate an activity-based travel model component and a network assignment component into a land-use model (UrbanSim) and to tightly couple this system to air emissions models.

4.4.3 Emissions Changes Due to Changing Ecosystems: Biogenic VOCs

Changing amounts and distributions of biogenic emissions due to land-use and climate changes is potentially a key factor for future air quality, as discussed throughout this report. Past studies have shown that emissions of VOCs from forest ecosystems can cause increases in pollution in near-urban and suburban areas. In one example, VOC emissions from forests near Atlanta entirely offset the effects of the policies put in place to reduce mobile-source emissions.

As described above, substantial uncertainty remains in modeling biogenic emissions. As part of the assessment effort, EPA is supporting studies on the VOC-emitting species in the current climate. Fundamental scientific questions are being addressed concerning the chemical and physical properties of primary and secondary organic aerosols (POAs, SOAs), the identity of

the biogenic VOCs that form SOAs, and the sensitivity of VOCs, POAs, and SOAs emission and formation rates to changes in environmental conditions. In addition, much research is being done outside the EPA sphere that is expected to contribute new findings to the assessment as it moves forward.

4.4.4 Emissions Changes Due to Changing Ecosystems: Wildfires

Fires, both natural and anthropogenic, have significant impacts on U.S. air quality, especially on PM concentrations. Recent studies show that fires in North America can have important effects on U.S. visibility and air quality on an episodic basis. Climate variability influences the extent and intensity of fires, e.g., moist years followed by dry years produce very favorable conditions for wildfires. Climate change, which is very likely to increase the frequency of precipitation in some areas, drought in other areas, and produce higher temperatures in general, may enhance future fire frequency, extent, and intensity regionally.

Therefore, along with better model representations of the effects of climate change on biogenic VOC emissions, simulations of the effects of climate on air quality should also consider changing levels in wildfire-generated O_3 and PM precursor emissions. Three modeling studies are underway that integrate the complex interactions of fire, climate, and air quality and are exploring important uncertainties. Two groups are focusing on the U.S. Southeast as a test case, with the third working to evaluate wildfire changes across the continental United States as a whole. All three teams are working to develop integrated models that account for fire-related changes in ecosystems in a warming climate, such as the extent of vegetative cover and fuel characteristics. State-level fire statistics, along with ground and satellite observations, will be used to evaluate the performance of the modeling systems. In addition, the continental-scale study will develop a climatology of plume heights from forest fires since 2000, and will relate plume heights to area burned for use in the climate change scenarios.

4.4.5 Taking Integrated Emissions Scenarios Through to Future U.S. Regional Air Quality

As shown in Figure 4-1, Phase II of the assessment will involve integrating these demographic, land-use, economics, transportation and energy models to produce a series of future emissions scenarios as input for the integrated climate and regional air quality models developed in Phase I of the program. Building on the improved understanding from the work already accomplished, and the new insights that will emerge in the near future, an important task will be to identify a subset of emission scenarios that capture the range of desired assumptions and outcomes to explore the critical questions of interest in the integrated climate and emissions modeling efforts. Conducting a series of sensitivity test simulations over shorter time periods, so

that a wider range of emissions scenarios can be tested, will likely be a key aspect of the research design. The results from these sensitivity tests will provide guidance on which set of scenarios offers sufficient representation of the range of plausible emissions changes for the future.

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EPA-2528

Ben DeAngelo/DC/USEPA/US
12/01/2009 04:17 PM

To David Chalmers
cc Rona Birnbaum
bcc
Subject Re: important question from Carol

Think that's a fair statement. (b)(5) Deliberative

David Chalmers Rona and Ben: Carol added the text h... 12/01/2009 03:53:43 PM

From: David Chalmers/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/01/2009 03:53 PM
Subject: important question from Carol

Rona and Ben:

Carol added the text highlighted below to a response on abrupt climate change and asked that we triple check to make sure it's accurate. Please let me know if you think it's okay to include as written.

The comment:

(b)(5) Deliberative

The relevant part of the response:

(b)(5) Deliberative

Thanks,
David

EPA-2530

"Mae Thomas" <Mae.Thomas@erg.com>
12/01/2009 04:42 PM

To Lesley Jantarasami
cc William Perkins, "Mae Thomas", "Tracy Parham"
bcc
Subject Re: found one commenter number for vol 11

Thanks Lesley! Tracy is going to look at this tonight, so we should have an answer for you in the morning.

Mae

>>> <Jantarasami.Lesley@epamail.epa.gov> 12/1/2009 11:09 AM >>>

Hi Mae,

We found a commenter number for the comment 11-24, so the only one missing now is from 11-22 (copied below). Carol, the author of the comment, thinks this came from ANPR comments. If you'd like to see the
latest version of vol 11, I've attached it.

Thanks,

Lesley

Comment (11-22):

(b)(5) Deliberative

[redacted]

(See attached file: RTC Volume 11 to ERG 11 30 09 ERG formatted CLEAN.doc)

Lesley Jantarasami
US EPA, Climate Change Division
Climate Science & Impacts Branch
202.343.9929
202.343.2202 (fax)

EPA-2531

Lesley Jantarasami/DC/USEPA/US
12/01/2009 05:01 PM

To Ben DeAngelo
cc
bcc
Subject Foreword

(b)(5) Deliberative

FOREWORD.doc

Thanks!

EPA-2532

Ben DeAngelo/DC/USEPA/US
12/01/2009 05:16 PM

To Lesley Jantarasami
cc
bcc
Subject Re: Foreword

Have just a few suggested edits embedded.

(b)(5) Deliberative

FOREWORD bjd.doc

Lesley Jantarasami Thanks! 12/01/2009 05:01:39 PM

From: Lesley Jantarasami/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US
Date: 12/01/2009 05:01 PM
Subject: Foreword

[attachment "FOREWORD.doc" deleted by Ben DeAngelo/DC/USEPA/US]

Thanks!

EPA-2533

John Hannon/DC/USEPA/US
12/01/2009 05:23 PM

To Michael Kolian
cc Ben DeAngelo
bcc
Subject Re: The latest Volume 5

Tanks Mike. I looked over the IA to see what I could glean, and I think I'll suggest the following change to the TSD insert re increases/decreases. What do you think?

(b)(5) Deliberative

TSD p 90 to 91 Ozone insert -jh1201.doc

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Michael Kolian Hi John, These are great questions. Y... 12/01/2009 05:16:42 PM

From: Michael Kolian/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA
Cc: John Hannon/DC/USEPA/US@EPA
Date: 12/01/2009 05:16 PM
Subject: Re: The latest Volume 5

Hi John,
These are great questions. You may have already talked with Ben but some additional information which may or may not help. First, (b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

Regarding the text, I think it's possible to reconcile the insert with preceding language.

(b)(5) Deliberative

On a separate topic ORD has suggested the following update to the TSD (b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

[redacted]

Ben DeAngelo Here's the underlying IA. Am continuin... 12/01/2009 03:56:41 PM

From: Ben DeAngelo/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:56 PM
Subject: Re: The latest Volume 5

Here's the underlying IA. Am continuing to work on ag for now.

[attachment "GCAQ report 4-8-09.pdf" deleted by Michael Kolian/DC/USEPA/US]

John Hannon This is the e-mail I just sent him on that:... 12/01/2009 03:38:38 PM

From: John Hannon/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:38 PM
Subject: Re: The latest Volume 5

This is the e-mail I just sent him on that:

Ben, could you send me the IA? The insert refers to a Table from it.

A quick reaction to the insert:

(b)(5) Deliberative

[redacted]

(b)(5) Deliberative

[redacted]

I still have a lot of questions on this, we should talk..

John Hannon
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U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Rona Birnbaum hi John, I believe Ben sent you an emai... 12/01/2009 03:16:40 PM

From: Rona Birnbaum/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:16 PM
Subject: Re: The latest Volume 5

hi John, I believe Ben sent you an email earlier today that pulled that out for you to have a look. see if that helps.

thanks, Rona

John Hannon Since this is not in RLSO, is there a wa... 12/01/2009 03:00:40 PM

From: John Hannon/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:00 PM
Subject: Re: The latest Volume 5

Since this is not in RLSO, is there a way to quickly point me to the new ozone stuff?

John Hannon

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Phone (202) 564-5563
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Jason Samenow | We've made quite a few edits to Volu... | 12/01/2009 11:03:57 AM

From: Jason Samenow/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA
Date: 12/01/2009 11:03 AM
Subject: The latest Volume 5

We've made quite a few edits to Volume 5 to respond to John's comments [redacted] (b)(5) Deliberative [redacted] There are undoubtedly still unresolved issues to work through, but this is getting closer. Comment bubbles remain in the margins where we have issues to address (though it's possible in a few cases we actually addressed the comment but neglected to delete the bubble).

Please find the Volume attached.

Thanks for everyone's collective efforts on working through this challenging, and lengthy volume.

Jason

[attachment "RTC Vol 5 120109.doc" deleted by John Hannon/DC/USEPA/US]

EPA-2534

Marcus Sarofim/DC/USEPA/US
12/01/2009 05:32 PM

To Lesley Jantarasami
cc
bcc
Subject

(b)(5) Deliberative [redacted] (b)(5) Deliberative [redacted]

volume3+4references.doc RTC draft Volume 3 Attribution 112209 csh 11 24-mcs.doc

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

EPA-2535

Marcus Sarofim/DC/USEPA/US
12/01/2009 05:39 PM

To David Chalmers
cc
bcc
Subject volume 3

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

----- Forwarded by Marcus Sarofim/DC/USEPA/US on 12/01/2009 05:38 PM -----

From: Marcus Sarofim/DC/USEPA/US
To: Lesley Jantarasami/DC/USEPA/US@EPA
Date: 12/01/2009 05:32 PM
Subject:

(b)(5) Deliberative [redacted]

RTC draft Volume 3 Attribution 112209 csh 11 24-mcs.doc

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1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

EPA-2536

David Chalmers/DC/USEPA/US
12/01/2009 05:47 PM

To Marcus Sarofim
cc
bcc
Subject just as a reminder

(b)(5) Deliberative

[redacted]

David Chalmers
ORISE Fellow
U.S. EPA, Climate Change Division
202.343.9814

EPA-2537

David Chalmers/DC/USEPA/US
12/01/2009 05:50 PM

To Marcus Sarofim
cc
bcc
Subject a fun one if you have time

I think this is already covered enough, though we could probably expand the summary.

Commenter Name: John R. Christy
Commenter Affiliation: none
Commenter Type:
Document Control Number: EPA-HQ-OAR-2009-0171-3215.1
Comment Excerpt Number: 3
Form Letter? No
Late Comment? No
Comment Changed? No
View Original Comment Letter

Part III.C. The Administrator's Proposed Finding That the Air Pollution Endangers Public Health and Welfare Part 1. Evidence of currently observed climatic and related effects (18898) Condensed EPA Assertion 3: Climate models have enough precision to allow EPA to make the assertions stated in this section, i.e. "… most of the observed global and continental warming can be attributed to this anthropogenic rise in greenhouse gases." And "… changes are occurring now that can be attributed to the anthropogenic rise in atmospheric greenhouse gases …" Bottom Line 3.1: Climate model output has failed to reproduce current tropical changes, a key greenhouse detection region, significantly overstating the very modest warming. The information in CCSP 1.1 (Karl et al. 2006) is biased, but more importantly, out of date. Explanation 3.1: That climate models have serious shortcomings is not a new scientific finding. However, it is well known that the clearest signal of model-projected greenhouse warming is found in a rapidly warming tropical troposphere. This issue has been examined by both the IPCC and CCSP (SAP 1.1, Karl et al. 2006) with disappointing analysis. I want the EPA to know that those who write these consensus reports are people who often serve as gatekeepers of these issues. I have served on these panels and have witnessed the heavy-handed tactics of the authors. The majority of these authors are selected by their governments for their specific view on climate change, not because of their scientific productivity on the issue at hand. I struggled with the other CCSP lead authors, as detailed in my House Testimony of 2006 (Christy 2006), for a more accurate rendering of the summary statements, but was unsuccessful. Thus "consensus" is less than what it appears to be. With that as a background, the fundamental issue here is that climate model simulations produce temperature changes in the tropics that show the upper air warms more than the surface as a very distinct signature of the enhanced greenhouse effect. At certain altitudes, the warming is twice (or more) that of the surface in the models. So, a simple hypothesis test can be performed which compares the upper air temperature trends to the surface using observations and models. Models show that the upper air layer-average trend is 1.3 times that of the surface. The factor of 1.3 is often called an amplification factor or amplification ratio. Let me say here that one point of confusion occurs immediately. One can say that the surface and tropospheric trends are consistent (i.e. not statistically different) in the sense that their magnitudes are similar (i.e. an amplification ratio of 1.0). However, the real scientific discussion deals with the fact that in the tropics climate models indicate that tropospheric trend should be about 1.3 times greater than the surface if models have greenhouse theory correctly simulated. Thus when someone says the discrepancy between the surface and tropospheric trends has been resolved with no difference between them, this becomes a misleading statement because it also implies that the troposphere is warming no more than the surface, which is therefore inconsistent with model greenhouse theory on which the current EPA relies. We have continued to look at this issue beyond CCSP (and the IPCC which simply followed the CCSP findings) and now have even further evidence to demonstrate that this well-known discrepancy is indeed real and that the models have erred significantly. In Christy et al. 2007, the most detailed analysis to date was performed on all balloon stations in the tropics (20°S - 20°N) in comparison with all datasets available at the time and concluded the observed upper air tropical trend was not 1.3 times that of the surface (it was less). While much was in the paper, one interesting result was that a satellite dataset produced by Remote Sensing Systems (RSS, which indicated a warmer temperature trend than the other datasets) contained a discontinuity in 1992 that was especially strong in the tropics. This feature was confirmed in three other studies which used different tests to demonstrate also that the trend of RSS was spuriously too positive (Christy et al. 2006, Randall and Herman 2008 and Christy and Norris 2009.) In this last paper (Christy and Norris 2009) we also demonstrated that the new NOAA-produced satellite dataset (STAR) has serious problems due to errors in correcting diurnal problems and intersatellite biases. These results were not included by the CCSP or IPCC panels to influence the "consensus" (the publications were after CCSP and thus IPCC had closed), but their results remain unchallenged and should be accepted by the EPA as peer-reviewed, published

findings. [Note: A different paper, Douglass et al. 2007, which demonstrated the model failures, was challenged as will be discussed below.] A simple way to look at this basic issue is that models show an amplification of temperature trends through the troposphere caused by greenhouse gases, so that whatever the trend is at the surface, the upper air trends warm by up to a factor of 2 (and more) by 12 km altitude. The average factor for the layer (which satellites measure) is 1.3, i.e. the layer measured by satellites should warm by a factor of 1.3 faster than the surface according to the greenhouse theory in models. The results of Christy et al. 2007 indicate the factor is not 1.3, but 0.7 to 1.0 (when RSS is discounted) – i.e. no amplification and thus models over-warm the atmosphere. Douglass et al. 2007 (I was a co-author) followed up with a detailed comparison of observations and models to demonstrate a significant difference between the two using both satellites and balloons, or that the model hypothesis of an amplification factor was falsified – important because that is the key signature of greenhouse gases in the models. It didn't take long for the "consensus" side, which earlier dominated CCSP 1.1 (Karl et al. 2006), to respond. Santer et al. 2008 reconfirmed the numerical results of the question addressed by Douglass et al. 2007. Our question was simply, "When the models and the observations have the same surface temperature trend, do the models and observations agree in the troposphere?" The answer was no. In other words, Santer et al. reproduced the results of Douglass et al. 2007. However, Santer et al. then asked a different question, which might have interest to some, but was not our question as stated above. They asked something like this, "When individual model trends of the surface are allowed to be examined, whether they agree with the observations or not, do upper air trends between models and observations agree?" Not surprisingly, because some individual model trends are quite bizarre, they could answer in the affirmative, but only for models whose surface temperature did match the observed surface trend. In other words we compared apples to apples and Santer et al. compared apples to oranges. When going back to the fundamental issue of whether models overstate the atmospheric amplification factor, the answer is clearly yes from the observations and models we have. (And in an ironic result, had Santer et al. used UAH satellite data through the most recent year, the models would have failed their test in any case.) In the analysis, Santer et al. used some "old", "modified" (i.e. SSTs only) and "new" datasets that (a) revealed less surface warming or (b) more upper tropospheric w arming. By using these datasets, the apparent discrepancy could be reduced (i.e. cooling the surface or warming up the troposphere in the observations). Then, one unorthodox trick was added - the use of Sea Surface Temperatures (SSTs) only and ignoring the warming of the land temperatures as if they did not matter (which is incredulous since the upper air resides over land too.) Regarding the SST datasets, they used a "new" one – ERSST - which indicated less warming at the surface so when multiplied by the model-calculated factor of 1.3, implies less warming in the upper air which then was closer to our upper air observations. However, the version of ERSST used in the paper is now obsolete (obsolete trend was +0.076, new trend is now +0.126 °C/decade - 65% warmer!), so the consistency arguments of Santer et al. based on the old ERSST are obsolete as well. The figure below, from Santer et al. 2008 but supplemented with pink comments, is quite complicated, but contains much of the information described herein. This is a diagram of the vertical atmosphere and superimposed are trends for 1979-1999 from various balloon observations and IPCC AR4 model results. The key point here is that the pink cage represents the entire range of model trends under the assumption they produced the observed surface trend (i.e. this gives an apples to apples comparison between models and observations). As can be seen, the observations (brown, red, green, orange lines) lie to the left (cooler) than the coolest of the model trends for the bulk of the lower atmosphere (700-400 hPa). Only part of the RICH (red) trends penetrate the cage, though, RICH is influenced by the ERA-40 model forecast scheme which has a clearly demonstrated spurious warming due to improper assimilation of HIRS channel 11 (which renders RAOBCORE v1.2-1.4 obsolete, see below.) The other balloon datasets are not affected by that problem. [See submittal for diagram provided by commenter] In another curious avoidance, Santer et al. did not include surface datasets generated by NOAA/NCDC and NASA/GISS to confuse the overall picture again. When these datasets are used (with their higher surface trends pointing to higher upper air trends when multiplied by 1.3), they indeed more closely support the results of Christy et al. 2007 and Douglass et al. 2007 that upper air trends of models and observations are significantly different. Regarding the upper air trend datasets, Santer et al. included RAOBCORE v1.2, v1.3 and v.1.4, which appeared to show a fairly rapidly warming in the upper tropical troposphere (see Fig.) However, the RAOBCORE datasets, which rely on the ERA-40 forecast cycle, have been shown to be spuriously warm in the upper air due to an error in the assimilation of HIRS channel 11 in 1991-2 (noted in earlier papers, but specifically identified in Sakamoto and Christy, 2009). Rather, Christy et al. 2007 and Douglass et al. 2007 used the latest version from the RAOBCORE group - RICH, which was also affected by the spurious warmth in 1991-2 but not as much, and yet found the inconsistency with models was indeed upheld for the layer-average. Again, relying on the various datasets, which have been tested for accuracy, we find no evidence to contradict the results of Christy et al. 2007 and Douglass et al. 2007. (Note the caveat, "which have been tested for accuracy" - papers such as Santer et al. 2008 do no testing, but simply assume that all datasets are equal, such as "new" ERSST or "old" RAOBCORE v1.2, v1.3 and v1.4, and thus ignore the publications which have provided the evidence which document significant errors in the ones they prefer.) There is much, much more available on this topic, but I will leave it here. Please contact me for more information/clarification if needed. [Repeated] Warning: The EPA will be tempted to rely on scientists/appointees who are well-entrenched into a particular view of the issue of global warming to review documents such as this, and who will (a) develop clever-sounding rebuttals, and (b) are afforded the luxury of the "last word" to protect the current EPA consensus. Basic scientific inquiry should encourage EPA to listen to those of us who actually build these datasets (from scratch) as our message has equal if not greater credibility. Main References Christy, J.R., W.B. Norris, K. Redmond and K. Gallo, 2006: Methodology and results of

calculating central California surface temperature trends: Evidence of human-induced climate change? J. Climate, 19, 548-563. Christy, J.R. and W.B. Norris, 2006: Satellite and VIZ-Radiosonde intercomparisons for diagnosis on non-climatic influences. J. Atmos. Oc. Tech., 23, 1181-1194. Christy, J.R. 2006: Testimony, House Committee on Energy and Commerce, Subcommittee on Oversight and Investigations. 27 July 2006. Christy, J.R., W.B. Norris and K.P. Gallo, 2007: Reply. J. Climate, 20, 4490-4493 Christy, J. R., W. B. Norris, R. W. Spencer, and J. J. Hnilo, 2007: Tropospheric temperature change since 1979 from tropical radiosonde and satellite measurements, J. Geophys. Res., 112, D06102, doi:10.1029/2005JD006881. Christy, J.R. and W.B. Norris, 2009: Discontinuity issues with radiosondes and satellite temperatures in the Australian region 1979-2006. J. Atmos. Oc. Tech., 26, 508-522, DOI: 10.1 175/2008JTECHA1126.1 Christy, J.R., W.B. Norris and R.T. McNider, 2009: Surface temperature variations in East Africa and possible causes. J. Clim. 22, DOI: 10.1175/2008JCLI2726.1. Douglass, D.H., J.R. Christy, B.D. Pearson and S.F. Singer, 2007: A comparison of tropical temperature trends with model predictions. International J. Climatology, DOI: 10.1002/joc.1651. Easterling, D. R., and M. F. Wehner (2009), Is the climate warming or cooling?, Geophys. Res. Lett., 36, L08706, doi: 10.1029/2009GL037810. Sakamoto, M. and J.R. Christy, 2009: The influences of TOVS radiance assimilation on temperature and moisture tendencies in JRA-25 and ERA-40. J. Atmos. Oc. Tech., doi:10.1175/2009JTECHA1193.1. Santer, B.D. et al., 2008: Consistency of modeled and observed temperature trends in the tropical troposphere. International J. Climatology, DOI: 10.1002/joc.1756. Walters, J.T., R.T. McNider, X. Shi, W.B. Norris and J.R. Christy, 2007: Positive surface temperature feedback in the stable nocturnal boundary layer. Geophys. Res. Lett. doi: 10.1029/2007GL029505.

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202.343.9814

EPA-2538

Lesley Jantarasami/DC/USEPA/US
12/01/2009 05:55 PM

To "Mae Thomas"
cc William Perkins
bcc
Subject updated references list

Hi Mae,

Here is an updated list of references for our volumes (includes ones you already saw in the old list). Vol 5 is with you now for copyediting, so I didn't include that. Also, we were wondering if you could help us generate references lists for vol 9 and 10. There should only be a handful, so hopefully should be pretty easy to find them. I've attached the files below. Please let me know if you have any questions!

Thanks,

Lesley

(b)(5) Deliberative
References 12 01 09.doc

(b)(5) Deliberative
RTC draft Volume 9 for ERG references.doc

(b)(5) Deliberative
RTC draft Volume 10 - to ERG for numbering 112209.doc

Lesley Jantarasami
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Climate Science & Impacts Branch
202.343.9929
202.343.2202 (fax)
Jantarasami.Lesley@epa.gov

EPA-2539

Lesley Jantarasami
04/01/2010 03:47 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\02_Comments and Responses\03_Other\FOREWORD.doc

(b)(5) Deliberative - FOREWORD.doc

EPA-2540

Jason Samenow/DC/USEPA/US
12/01/2009 06:05 PM

To Marcus Sarofim
cc David Chalmers
bcc
Subject Re: do we cover this in vol 4?

awesome... i'm q/c ing the database for vol 2, and came across that one.

thanks!

jason

Marcus Sarofim (b)(5) Deliberative 12/01/2009 06:03:13 PM

From: Marcus Sarofim/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA
Date: 12/01/2009 06:03 PM
Subject: Re: do we cover this in vol 4?

(b)(5) Deliberative

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

Jason Samenow Commenter Name: Sam Cyotie Com... 12/01/2009 06:01:18 PM

From: Jason Samenow/DC/USEPA/US
To: David Chalmers/DC/USEPA/US@EPA, Marcus Sarofim/DC/USEPA/US@EPA
Date: 12/01/2009 06:01 PM
Subject: do we cover this in vol 4?

Commenter Name: Sam Cyotie
Commenter Affiliation: None
Commenter Type:
Document Control Number: EPA-HQ-OAR-2009-0171-0582
Comment Excerpt Number: 8
Form Letter? No
Late Comment? No
Comment Changed? No
View Original Comment Letter

[The commenter submitted the following news article] INTERNAL MODELING MISTAKES BY IPCC ARE SUFFICIENT TO REJECT ITS ANTHROPOGENIC GLOBAL WARMING CONJECTURE Pluss Over 100 prominent scientists from more than a dozen countries, including a Nobel Prize winner, have signed a letter to President Barack Obama charging that his views on climate change are “simply incorrect.” Under the headline, “With all due respect, Mr. President, that is not true,” the scientists state: “We, the undersigned scientists, maintain that the case for alarm regarding climate change is grossly overstated. Surface temperature changes over the past century have been episodic and modest and there has been no net global warming for over a decade now… “The computer models forecasting rapid temperature change abjectly fail to explain recent climate behavior. Mr. President, your characterization of the scientific facts regarding climate change and the degree of certainty informing the scientific debate is simply incorrect.” The 115 signatories include Ivar Giaever, Ph.D., who shared the Nobel Prize for Physics in 1973 for his work with superconductors at General Electric; John Blaylock, formerly with

the Los Alamos National Laboratory; Richard Lindzen, Ph.D., at the Massachusetts Institute of Technol,ogy; and William Gray, Ph.D., the respected hurricane expert at Colorado State University. The signers include scientists at Princeton University, U.S. Naval Academy, University of Kansas, University of Oklahoma, University of Colorado, and University of Missouri. Among the countries represented by the signers are Britain, Canada, Italy, Norway, Germany, Australia, New Zealand, Japan, Argentina and South Africa. A number of the scientists are current or former reviewers with the United Nations' Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize with climate change crusader Al Gore, and have since reversed their views on man-made global warming.

EPA-2541

Marcus Sarofim/DC/USEPA/US
12/01/2009 06:11 PM

To Jason Samenow
cc Ben DeAngelo
bcc
Subject TSD addition, carbon cycle projections?

(b)(5) Deliberative

Also, for Ben, here's the carbon sink comment:

Comment:

(b)(5) Deliberative

(b)(5) Deliberative

Response:

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

[redacted]

Marcus C. Sarofim, PhD
phone: 202-343-9993
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1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

EPA-2542

Ben DeAngelo
04/06/2010 04:56 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\owner\My Documents\Endangerment\Response to Public Comments\FOREWORD bjd.doc

(b)(5) Deliberative [redacted]- FOREWORD bjd.doc

EPA-2543

Lesley Jantarasami
04/01/2010 03:47 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\02_Comments and Responses\03_Other\FOREWORD edits 12 01 09.doc

(b)(5) Deliberative [redacted] - FOREWORD edits 12 01 09.doc

EPA-2544

Lesley Jantarasami
04/01/2010 03:44 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\01_Full Doc\Quikr drop 11 20 through 30\RTC draft Volume 1 General TSD Approach 11-24-09.doc

(b)(5) Deliberative [redacted] - RTC draft Volume 1 General TSD Approach 11-24-09.doc

EPA-2545

Lesley Jantarasami
04/01/2010 03:44 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\01_Full Doc\Quikr drop 11 20 through 30\RTC draft Volume 7 Water, Coastal, Eco 11-28-09.doc

(b)(5) Deliberative - RTC draft Volume 7 Water, Coastal, Eco 11-28-09.doc

EPA-2546

Michael Kolian
05/12/2010 10:15 AM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\Owner\My Documents\Ccd\TSD comment period\RTC Document and Outline\Volume 5\December\TSD p 90 to 91 Ozone insert -jh1201.doc

(b)(5) Deliberative - TSD p 90 to 91 Ozone insert -jh1201.doc

EPA-2547

Lesley Jantarasami
04/01/2010 03:44 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\01_Full Doc\Quikr drop 11 20 through 30\RTC draft Volume 9 for ERG references.doc

(b)(5) Deliberative [redacted] - RTC draft Volume 9 for ERG references.doc

EPA-2548

John Hannon/DC/USEPA/US
12/01/2009 06:26 PM

To Michael Kolian
cc Ben DeAngelo
bcc
Subject Re: The latest Volume 5

I think it would help to add it to the TSD, (b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

[redacted]

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1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Michael Kolian I think that's reasonable and supported... 12/01/2009 05:40:18 PM

From: Michael Kolian/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA
Date: 12/01/2009 05:40 PM
Subject: Re: The latest Volume 5

I think that's reasonable and supported by the figure. We'll just want to run by the IA folks.

Do you guys think it's helpful to add something like this language to the TSD?

(b)(5) Deliberative

[redacted]

John Hannon Tanks Mike. I looked over the IA to see... 12/01/2009 05:23:57 PM

From: John Hannon/DC/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA
Date: 12/01/2009 05:23 PM
Subject: Re: The latest Volume 5

Tanks Mike. I looked over the IA to see what I could glean, and I think I'll suggest the following change to the TSD insert re increases/decreases. What do you think?

[attachment "TSD p 90 to 91 Ozone insert -jh1201.doc" deleted by Michael Kolian/DC/USEPA/US]

John Hannon
Office of General Counsel
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1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Michael Kolian Hi John, These are great questions. Y... 12/01/2009 05:16:42 PM

From: Michael Kolian/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA
Cc: John Hannon/DC/USEPA/US@EPA
Date: 12/01/2009 05:16 PM
Subject: Re: The latest Volume 5

Hi John,
These are great questions. You may have already talked with Ben but some additional information which may or may not help. First, (b)(5) Deliberative

(b)(5) Deliberative

Regarding the text, I think it's possible to reconcile the insert with preceding language.

(b)(5) Deliberative

On a separate topic ORD has suggested the following update to the TSD (b)(5) Deliberative

(b)(5) Deliberative

Ben DeAngelo Here's the underlying IA. Am continuin... 12/01/2009 03:56:41 PM

From: Ben DeAngelo/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:56 PM
Subject: Re: The latest Volume 5

Here's the underlying IA. Am continuing to work on ag for now.

[attachment "GCAQ report 4-8-09.pdf" deleted by Michael Kolian/DC/USEPA/US]

John Hannon This is the e-mail I just sent him on that:... 12/01/2009 03:38:38 PM

From: John Hannon/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:38 PM
Subject: Re: The latest Volume 5

This is the e-mail I just sent him on that:

Ben, could you send me the IA? The insert refers to a Table from it.

A quick reaction to the insert:

(b)(5) Deliberative

I still have a lot of questions on this, we should talk..

John Hannon
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Fax (202 564-5603

Rona Birnbaum hi John, I believe Ben sent you an emai... 12/01/2009 03:16:40 PM

From: Rona Birnbaum/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:16 PM
Subject: Re: The latest Volume 5

hi John, I believe Ben sent you an email earlier today that pulled that out for you to have a look. see if that helps.

thanks, Rona

John Hannon Since this is not in RLSO, is there a wa... 12/01/2009 03:00:40 PM

From: John Hannon/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:00 PM
Subject: Re: The latest Volume 5

Since this is not in RLSO, is there a way to quickly point me to the new ozone stuff?

John Hannon
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Fax (202 564-5603

Jason Samenow We've made quite a few edits to Volu... 12/01/2009 11:03:57 AM

From: Jason Samenow/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA
Date: 12/01/2009 11:03 AM
Subject: The latest Volume 5

We've made quite a few edits to Volume 5 to respond to John's comments (b)(5) Deliberative There are undoubtedly still unresolved issues to work through, but this is getting closer. Comment bubbles remain in the margins where we have issues to address (though it's possible in a few cases we actually addressed the comment but neglected to delete the bubble).

Please find the Volume attached.

Thanks for everyone's collective efforts on working through this challenging, and lengthy volume.

Jason

[attachment "RTC Vol 5 120109.doc" deleted by John Hannon/DC/USEPA/US]

EPA-2549

Marcus Sarofim
04/01/2010 08:02 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\msarofim\My Documents\WorkFolder\Tsd_Anpr\ResponseToComments\Volumes\volume3+4references.doc

(b)(5) Deliberative - volume3+4references.doc

EPA-2551

Lesley Jantarasami
04/01/2010 03:48 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\02_Comments and Responses\03_Other\References 12 01 09.doc

(b)(5) Deliberative [redacted] - References 12 01 09.doc

EPA-2552

Marcus Sarofim
04/01/2010 08:01 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\msarofim\My Documents\WorkFolder\Tsd_Anpr\ResponseToComments\Volumes\RTC draft Volume 3 Attribution 112209 csh 11 24-mcs.doc

(b)(5) Deliberative - RTC draft Volume 3 Attribution 112209 csh 11 24-mcs.doc

EPA-2553

Suzanne Kocchi/DC/USEPA/US
12/01/2009 06:52 PM

To Bill Irving, Brian Mclean
cc "kocchi suzanne"
bcc
Subject Re: Quick question

Bill is correct the 380000 is endangerment. I don't have thr MRR text in front of me but the standard thing we have been saying on MRR is approx 16000 comments total, 15000 sierra club mass mailer and 1000 unique substantive comments.
Bill Irving

----- Original Message -----
From: Bill Irving
Sent: 12/01/2009 06:48 PM EST
To: Brian Mclean
Cc: kocchi.suzanne@epa.gov
Subject: Re: Quick question

I think the 380,000 might be Endangerment comments. On the MRR we got approximately 15,000 comments, and over 13,000 came from a Sierra Club mass mailer telling us not to delay. Suzie would know with more precision if that's needed. Many of the substantive commenters on the MRR sent in multiple pages of comments.

Bill

Brian Mclean Is it correct to say that the number of co... 12/01/2009 06:44:24 PM

From: Brian Mclean/DC/USEPA/US
To: Bill Irving/DC/USEPA/US@EPA
Date: 12/01/2009 06:44 PM
Subject: Quick question

Is it correct to say that the number of comments on MRR are "over 380,000"?

Thanks

EPA-2554

Ben DeAngelo
04/06/2010 04:56 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\owner\My Documents\Endangerment\Response to Public Comments\FOREWORD edits 12 01 09.doc

(b)(5) Deliberative [redacted] - FOREWORD edits 12 01 09.doc

EPA-2555

Michael Kolian/DC/USEPA/US
12/01/2009 07:03 PM

To Lesley Jantarasami
cc Ben DeAngelo
bcc
Subject forestry

Lesley,
Please give a review. There are still some outstanding issues but could use another swipe through at this point.

Cheers,
Mike

(b)(5) Deliberative

RTC_draft_Volume_6_Forestry_only 120109 BJD.doc

EPA-2556

Jason Samenow/DC/USEPA/US
12/01/2009 07:12 PM

To William Perkins
cc
bcc
Subject have you seen this comment set before?

I found this while doing a Google search on a study I was researching:

http://naturalclimatechange.com/documents/6-23-09-naturaldriverofclimatechangeendangermentcomments.pdf

It's a 200+ page technical comment set, but I don't recall ever seeing it.

(b)(5) Deliberative

Jason

EPA-2557

Michael Kolian/DC/USEPA/US
12/01/2009 07:33 PM

To Doug Grano
cc Ben DeAngelo
bcc
Subject Re: volume 5 Human Health and Air Quality (EPA only)

Thanks Doug!
The new language for the TSD looks good and OGC suggests modifying the findings slightly to match (see below). Also, Darrell and Chris were involved in the TSD edit.
Cheers,
Mike

I think it would help to add it to the TSD, (b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

Doug Grano Mike-- The 2 blue sentences below sho... 12/01/2009 04:42:13 PM

From: Doug Grano/RTP/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA
Date: 12/01/2009 04:42 PM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Mike--
The 2 blue sentences below should be added to the TSD (b)(5) Deliberative

The sentences recently added to the TSD referencing the IA and (b)(5) Deliberative should be reviewed by Darrell & Chris. The IA doesn't seem to use those terms and the sentences may need some revising. Also, I don't think (b)(5) Deliberative

--Doug

(b)(5) Deliberative

Michael Kolian I think your right on the control measur... 12/01/2009 09:41:54 AM

From: Michael Kolian/DC/USEPA/US
To: Doug Grano/RTP/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA
Date: 12/01/2009 09:41 AM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

I think your right on the control measures. We do refer commenters to this section in certain cases:
[redacted] (b)(5) Deliberative [redacted] However, we could more explicit in the responses.

I think your right too on attainment vs non-attainment areas. We have just added the following language to Section 8(a) of the TSD which sort of addresses your point. You can work from this if you think additional information is necessary and not too hard to pull together.

[attachment "Section 8a_tsd 11_27.doc" deleted by Doug Grano/RTP/USEPA/US]

Doug Grano Mike-- Two comments on the draft pag... 11/30/2009 05:02:50 PM

From: Doug Grano/RTP/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Date: 11/30/2009 05:02 PM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Mike--
Two comments on the draft pages you faxed.

last paragraph on page 72
[redacted] (b)(5) Deliberative [redacted]

last paragraph on page 73 (also on page 64)
[redacted] (b)(5) Deliberative [redacted]

--Doug

Michael Kolian Yes. This is the relevant part of the find... 11/25/2009 10:49:34 AM

From: Michael Kolian/DC/USEPA/US
To: Doug Grano/RTP/USEPA/US@EPA
Date: 11/25/2009 10:49 AM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Yes. This is the relevant part of the finding at Section IV.B which discusses how the administrator weighs the evidence. Also note the section that provides examples from commenters and our interpretation/treatment of the these.

Cheers, Mike

FYI: I may have a cleaner version of the volume 5 AQ to send soon.

Doug Grano Thanks--got pages 59-74 --Doug 11/25/2009 10:43:13 AM

From: Doug Grano/RTP/USEPA/US

To: Michael Kolian/DC/USEPA/US@EPA
Date: 11/25/2009 10:43 AM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Thanks--got pages 59-74
--Doug

Michael Kolian Doug, on the way..... 11/25/2009 10:11:58 AM

From: Michael Kolian/DC/USEPA/US
To: Doug Grano/RTP/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA
Date: 11/25/2009 10:11 AM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Doug, on the way.....

Doug Grano Your note mentioned being consistent... 11/25/2009 08:19:59 AM

From: Doug Grano/RTP/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA
Date: 11/25/2009 08:19 AM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Your note mentioned [redacted] (b)(5) Deliberative [redacted] If yes, my fax # is 919-541-5598
--Doug

Michael Kolian Hi Doug et al, I have incorporated your... 11/09/2009 06:17:55 PM

From: Michael Kolian/DC/USEPA/US
To: Doug Grano/RTP/USEPA/US@EPA
Cc: Anne Grambsch/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA, Dale Evarts/RTP/USEPA/US@EPA, Darrell Winner/DC/USEPA/US@EPA, Erika Sasser/RTP/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 11/09/2009 06:17 PM
Subject: Re: volume 5 Human Health and Air Quality (EPA only)

Hi Doug et al,
I have incorporated your comments along with others (thank you!).

1) [redacted] (b)(5) Deliberative [redacted]
2) I have attached a track changes version of the volume containing changes to the AQ section since it was created and a clean copy as of today.
3) It is still being reviewed and expect more changes so you will continue to get subsequent opportunities to review, etc... One thing going forward is we'll have [redacted] (b)(5) Deliberative [redacted]

[attachment "RTC draft Volume 5 HH and AQ 110909.doc" deleted by Doug Grano/RTP/USEPA/US]
[attachment "RTC draft Volume 5 HH and AQ 110909 clean.doc" deleted by Doug Grano/RTP/USEPA/US]

Cheers,
Mike

Doug Grano I've re-reviewed the AQ section and res... 11/06/2009 03:24:28 PM

From:	Doug Grano/RTP/USEPA/US
To:	Michael Kolian/DC/USEPA/US@EPA
Cc:	Anne Grambsch/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA, Darrell Winner/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Erika Sasser/RTP/USEPA/US@EPA, Dale Evarts/RTP/USEPA/US@EPA
Date:	11/06/2009 03:24 PM
Subject:	Re: volume 5 Human Health and Air Quality (EPA only)

I've re-reviewed the AQ section and responded to the comments/questions/style suggestions (attached).
(b)(5) Deliberative
Darrell should take a look at that portion of the RTC document (in 2 comment/responses).
Any word on next steps for the RTC? I'm assuming we will have more chances to go over the AQ section; e.g., once OGC review is completed.
--Doug
[attachment "RTC draft Volume 5 HH and AQ 110409a-DG.doc" deleted by Michael Kolian/DC/USEPA/US]

Michael Kolian Hi Doug and Darrell, We have combine... 11/04/2009 12:26:42 PM

From:	Michael Kolian/DC/USEPA/US
To:	Doug Grano/RTP/USEPA/US@EPA, Darrell Winner/DC/USEPA/US@EPA, Anne Grambsch/DC/USEPA/US@EPA
Cc:	Ben DeAngelo/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date:	11/04/2009 12:26 PM
Subject:	volume 5 Human Health and Air Quality (EPA only)

Hi Doug and Darrell,
(b)(5) Deliberative
. It would be great if you and your team could re-review the AQ section. There are a few outstanding minor comments/questions in the AQ section in particular. We anticipate additional comments/edits to the section (in red-line) from other reviewers so I'll will keep you in the loop.

Hi Anne,
I wonder if you could review the human heath section if you have the time. Any feedback would be great.

We're shooting for consistency in and among the various volumes by following some general guidelines (attached). It would be great if you could turn this around by the end of the week (preferably sooner). Please let me know if you have any questions.

Many thanks,
Mike

[attachment "RTC draft Volume 5 HH and AQ 110409a.doc" deleted by Doug Grano/RTP/USEPA/US]
[attachment "Reminders on Style and Wording v2.doc" deleted by Doug Grano/RTP/USEPA/US]

Michael Kolian, USEPA
Office of Atmospheric Programs
Climate Change Division
1200 Pennsylvania Avenue, NW (6207J)
Washington, DC 20460
Phone: (202) 343-9261
Email: kolian.michael@epa.gov

EPA-2558

Ben DeAngelo
04/06/2010 04:57 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\owner\My Documents\Endangerment\Response to Public Comments\RTC_draft_Volume_6_Forestry_only 120109 BJD 2.doc

(b)(5) Deliberative [redacted] - RTC_draft_Volume_6_Forestry_only 120109 BJD 2.doc

EPA-2559

Marcus Sarofim/DC/USEPA/US
12/01/2009 08:18 PM

To Jason Samenow
cc
bcc
Subject Re: do we address [redacted]

er... not yet...

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

Jason Samenow (eom) 12/01/2009 06:18:29 PM

From: Jason Samenow/DC/USEPA/US
To: Marcus Sarofim/DC/USEPA/US@EPA
Date: 12/01/2009 06:18 PM
Subject: do we address [redacted]

(eom)

EPA-2560

"Mae Thomas" <Mae.Thomas@erg.com>
12/01/2009 08:33 PM

To William Perkins
cc "Mae Thomas"
bcc
Subject List of References

Bill, you had asked for another draft of the reference list. It is attached. We still need to go through this again, but it is much better than it was the last time.

Thanks
mae

(b)(5) Deliberative

All Commenter References.xls

EPA-2561

William Perkins/DC/USEPA/US
12/01/2009 08:41 PM

To "Mae Thomas"
cc Jason Samenow, "Mae Thomas"
bcc
Subject Re: Urgent: have you seen this comment set before?

Mae,

Thank you very much. We'll take it from here and see what we find.

Cheers,

Bill

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

"Mae Thomas" I searched on the commenter names a... 12/01/2009 08:41:21 PM

From: "Mae Thomas" <Mae.Thomas@erg.com>
To: William Perkins/DC/USEPA/US@EPA
Cc: Jason Samenow/DC/USEPA/US@EPA, "Mae Thomas" <Mae.Thomas@erg.com>
Date: 12/01/2009 08:41 PM
Subject: Re: Urgent: have you seen this comment set before?

I searched on the commenter names and did not find these comments.

Mae

>>> <Perkins.William@epamail.epa.gov> 12/1/2009 8:39 PM >>>
Mae,

Thank you. If you don't see it after your additional search, then I'll ask David to check with the docket office folks in the morning and make sure that this wasn't missed somewhere in their process but actually submitted -- which would be a bad thing to say the least.

Cheers,

Bill

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460

(F) 202.343.2202
(C) (b)(6)

From: "Mae Thomas" <Mae.Thomas@erg.com>

To: William Perkins/DC/USEPA/US@EPA

Cc: Jason Samenow/DC/USEPA/US@EPA, "Mae Thomas" <Mae.Thomas@erg.com>

Date: 12/01/2009 08:18 PM

Subject: Re: Urgent: have you seen this comment set before?

I searched on every commenter name on the cover page and did not find comments submitted under any of their names. I searched the spreadsheet we downloaded from the Docket Office.

I'll go on regulations.gov and do some searching for good measure.

Mae

>>> <Perkins.William@epamail.epa.gov> 12/1/2009 7:42 PM >>>

Mae,

Jason found this on the web today, and we are not sure if it was submitted to the docket. We did not see this on regulations.gov in our docket; can you check through your systems ASAP to see if this was ever received? Thank you.

Bill

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

----- Forwarded by William Perkins/DC/USEPA/US on 12/01/2009 07:41 PM -----

From: Jason Samenow/DC/USEPA/US

To: William Perkins/DC/USEPA/US@EPA

Date: 12/01/2009 07:12 PM

Subject: have you seen this comment set before?

I found this while doing a Google search on a study I was researching:

http://naturalclimatechange.com/documents/6-23-09-naturaldriverofclimatechange endangermentcomments.pdf

It's a 200+ page technical comment set, but I don't recall ever seeing it.

Jason

EPA-2562

John Hannon/DC/USEPA/US
12/01/2009 08:44 PM

To Ben DeAngelo
cc Carol Holmes, Michael Kolian
bcc
Subject Re: The latest Volume 5

Ben and Michael, here are my edits to the AQ part of vol 5, 5.2. I tried to bring in more of the ideas about [redacted] (b)(5) Deliberative [redacted] I added various comment balloons, but they just get added in with the prior comment balloons.

(b)(5) Deliberative [redacted]
RTC Vol 5 120109 -jh1201 5.2.doc .

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Ben DeAngelo There's still work to be done (not a hug... 12/01/2009 06:41:57 PM

From: Ben DeAngelo/DC/USEPA/US
To: Dina Kruger/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 06:41 PM
Subject: Re: The latest Volume 5

There's still work to be done (not a huge amount) on the AQ section within 5, so there's plenty of material in 5 you can work through before getting to AQ. So we might have these issues resolved before you get to review AQ within 5 -- in that case we could reinsert that section.

Dina Kruger Based on the email chain, I'm wonderin... 12/01/2009 06:36:28 PM

From: Dina Kruger/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 06:36 PM
Subject: Re: The latest Volume 5

Based on the email chain, I'm wondering if I should turn to Vol 5 when I finish with 11, or wait until John and Ben finish up. Is it still a work in progress (at least in part)? I don't want to create a version control issue. Thanks -

Dina

Sent by EPA Wireless E-Mail Services

Ben DeAngelo

----- Original Message -----
From: Ben DeAngelo
Sent: 12/01/2009 03:56 PM EST
To: John Hannon
Cc: Carol Holmes; David Chalmers; Dina Kruger; Jason Samenow; Lesley Jantarasami; Michael Kolian; Rona Birnbaum; Suzanne Kocchi; William Perkins
Subject: Re: The latest Volume 5

Here's the underlying IA. Am continuing to work on ag for now.

[attachment "GCAQ report 4-8-09.pdf" deleted by Dina Kruger/DC/USEPA/US]

John Hannon This is the e-mail I just sent him on that:... 12/01/2009 03:38:38 PM

From:	John Hannon/DC/USEPA/US
To:	Rona Birnbaum/DC/USEPA/US@EPA
Cc:	Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date:	12/01/2009 03:38 PM
Subject:	Re: The latest Volume 5

This is the e-mail I just sent him on that:

Ben, could you send me the IA? The insert refers to a Table from it.

A quick reaction to the insert:

(b)(5) Deliberative

(b)(5) Deliberative

I still have a lot of questions on this, we should talk..

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Rona Birnbaum hi John, I believe Ben sent you an emai... 12/01/2009 03:16:40 PM

From: Rona Birnbaum/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:16 PM
Subject: Re: The latest Volume 5

hi John, I believe Ben sent you an email earlier today that pulled that out for you to have a look. see if that helps.

thanks, Rona

John Hannon Since this is not in RLSO, is there a wa... 12/01/2009 03:00:40 PM

From: John Hannon/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:00 PM
Subject: Re: The latest Volume 5

Since this is not in RLSO, is there a way to quickly point me to the new ozone stuff?

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Jason Samenow We've made quite a few edits to Volu... 12/01/2009 11:03:57 AM

From:	Jason Samenow/DC/USEPA/US
To:	William Perkins/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Cc:	Carol Holmes/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA
Date:	12/01/2009 11:03 AM
Subject:	The latest Volume 5

We've made quite a few edits to Volume 5 to respond to John's comments [redacted] There are undoubtedly still unresolved issues to work through, but this is getting closer. Comment bubbles remain in the margins where we have issues to address (though it's possible in a few cases we actually addressed the comment but neglected to delete the bubble).

Please find the Volume attached.

Thanks for everyone's collective efforts on working through this challenging, and lengthy volume.

Jason

[attachment "RTC Vol 5 120109.doc" deleted by John Hannon/DC/USEPA/US]

EPA-2563

Michael Kolian/DC/USEPA/US
12/01/2009 09:09 PM

To Chris Weaver
cc Ben DeAngelo, Darrell Winner
bcc
Subject Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Darrell, Chris:
Just want to make sure your comfortable with these changes to your last version. Cheers, Mike

(b)(5) Deliberative

TSD p 90 to 91 Ozone insert -jh1201.doc

Chris Weaver Hi, I'm at a conference off-site today a... 12/01/2009 10:57:38 AM

From: Chris Weaver/DC/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Cc: Darrell Winner/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA
Date: 12/01/2009 10:57 AM
Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Hi,

I'm at a conference off-site today and don't have access to Fig. 3-11 other than cutting it from the report as you attempted. I could get it to you tomorrow if that was okay.

As far as putting the figure in the TSD, the finding, or the response to comments, (b)(5) Deliberative

-Chris

-----Michael Kolian/DC/USEPA/US wrote: -----

To: Darrell Winner/DC/USEPA/US@EPA
From: Michael Kolian/DC/USEPA/US
Date: 12/01/2009 10:25AM
cc: Ben DeAngelo/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA
Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Terrific. Can you or Chris provide us with Figure 3-11? I can't seem to pull it from the pdf report. Also, not sure where we ended up regarding this figure along with the non-attainment areas.

Darrell Winner---12/01/2009 09:53:14 AM---Here is my attempt to clarify and simplify - -darrell

From: Darrell Winner/DC/USEPA/US

To: Michael Kolian/DC/USEPA/US@EPA

Cc: Ben DeAngelo/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA

Date: 12/01/2009 09:53 AM

Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Here is my attempt to clarify and simplify -

[attachment "Comment from John 3411.1_3347.3 daw 120109.doc" deleted by Michael Kolian/DC/USEPA/US]

-darrell

Darrell Winner, Ph.D.
Director, Applied Science Division
National Center for Environmental Research
winner.darrell@epa.gov
phone 202-343-9748
fax 202-233-0677

Regular mail:
USEPA/ORD/NCER/ASD (8726F)
1200 Pennsylvania Ave NW
Washington, DC 20460-0001

FedEx/Courier:
USEPA/ORD/NCER/ASD
Room 3111
1025 F St NW
Washington, DC 20004

(Woodies Building / metro stop: Metro Center)

Michael Kolian---11/30/2009 04:38:33 PM---Thanks for the quick response on the language. Can you guys review this one I separated from the res

From: Michael Kolian/DC/USEPA/US

To: Darrell Winner/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA

Cc: Ben DeAngelo/DC/USEPA/US@EPA

Date: 11/30/2009 04:38 PM

Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Thanks for the quick response on the language.

Can you guys review this one I separated from the response to comments document and take a crack at responding to John's comments?

Thanks,
Mike

[attachment "Comment from John 3411.1_3347.3.doc" deleted by Darrell Winner/DC/USEPA/US]

Darrell Winner---11/30/2009 04:34:22 PM---Here is the updated attachment - -darrell

From: Darrell Winner/DC/USEPA/US

To: Ben DeAngelo/DC/USEPA/US@EPA

Cc: Anne Grambsch/DC/USEPA/US@EPA, Bryan Bloomer/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA, Mike Kolian <kolian.michael@epa.gov>

Date: 11/30/2009 04:34 PM

Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Here is the updated attachment -
[attachment "TSD p 90 to 91 Ozone insert.doc" deleted by Michael Kolian/DC/USEPA/US]

-darrell

Darrell Winner, Ph.D.
Director, Applied Science Division
National Center for Environmental Research
winner.darrell@epa.gov
phone 202-343-9748
fax 202-233-0677

Regular mail:
USEPA/ORD/NCER/ASD (8726F)
1200 Pennsylvania Ave NW
Washington, DC 20460-0001

FedEx/Courier:
USEPA/ORD/NCER/ASD
Room 3111
1025 F St NW
Washington, DC 20004

(Woodies Building / metro stop: Metro Center)

Darrell Winner---11/30/2009 04:12:33 PM---Second draft, with Ben's sentence on urban areas also inserted to this section of text. Bryan's sugg

From: Darrell Winner/DC/USEPA/US

To: Ben DeAngelo/DC/USEPA/US@EPA

Cc: Anne Grambsch/DC/USEPA/US@EPA, Bryan Bloomer/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA, Mike Kolian <kolian.michael@epa.gov>

Date: 11/30/2009 04:12 PM

Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Second draft, with Ben's sentence on urban areas also inserted to this section of text.

[attachment "TSD p 90 to 91 Ozone insert.doc" deleted by Darrell Winner/DC/USEPA/US]

Bryan's suggestion to [redacted] (b)(5) Deliberative [redacted]

maybe something like -

[redacted] (b)(5) Deliberative [redacted]

-darrell

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Washington, DC 20004

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Darrell Winner---11/30/2009 03:19:54 PM---First attempt more to come

From: Darrell Winner/DC/USEPA/US

To: Ben DeAngelo/DC/USEPA/US@EPA

Cc: Anne Grambsch/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA, Mike Kolian <kolian.michael@epa.gov>, Bryan Bloomer/DC/USEPA/US@EPA

Date: 11/30/2009 03:19 PM

Subject: Re: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

First attempt

[attachment "TSD p 90 to 91 Ozone insert.doc" deleted by Darrell Winner/DC/USEPA/US]

more to come

_____
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Washington, DC 20004

(Woodies Building / metro stop: Metro Center)

Ben DeAngelo---11/30/2009 11:12:41 AM---Darrell, Anne, Chris, We're looking for some guidance to help respond to some comments but also to

From: Ben DeAngelo/DC/USEPA/US

To: Darrell Winner/DC/USEPA/US@EPA, Anne Grambsch/DC/USEPA/US@EPA, Chris Weaver/DC/USEPA/US@EPA

Cc: Mike Kolian <kolian.michael@epa.gov>

Date: 11/30/2009 11:12 AM

Subject: Fw: vol 5 (use this version, please) -- CALL AT 2 TODAY?!

Darrell, Anne, Chris,

We're looking for some guidance to help respond to some comments but also [redacted] (b)(5) Deliberative

Darrell said he's available at this time. Sorry for the late notice but we're in the final throws of getting everything together.

Can help explain on the phone. Think we're looking for [redacted] (b)(5) Deliberative

Thanks.
-Ben

----- Forwarded by Ben DeAngelo/DC/USEPA/US on 11/30/2009 11:01 AM -----

From: Ben DeAngelo/DC/USEPA/US

To: Darrell Winner/DC/USEPA/US@EPA

Cc: Mike Kolian <kolian.michael@epa.gov>

Date: 11/30/2009 09:40 AM

Subject: Fw: vol 5 (use this version, please)

Darrell,

Please see the comments below from John Hannon from OGC regarding our responses to comments [redacted] (b)(5) Deliberative

Would you have time today to get on a call to go over this??

Thanks for any help.

-Ben

----- Forwarded by Ben DeAngelo/DC/USEPA/US on 11/30/2009 09:36 AM -----

Fro m: John Hannon/DC/USEPA/US

To: Jason Samenow/DC/USEPA/US@EPA

Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Bill Perkins <perkins.william@epa.gov>, Rona Birnbaum/DC/USEPA/US@EPA

Dat e: 11/29/2009 01:00 PM

Sub ject: Re: vol 5 (use this version, please)

Here are comments on the rest of volume 5. Not much, except in the area of (b)(5) Deliberative [redacted]

I think this means two things:

(1) (b)(5) Deliberative [redacted]

[redacted]

[redacted]

(2) (b)(5) Deliberative

[redacted]

[attachment "RTC_draft_Volume_5_complete_1128 -jh1129.doc" deleted by Darrell Winner/DC/USEPA/US]

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Jason Samenow---11/28/2009 11:38:10 AM--- Sorry for multiple emails on this....but please refer to this version of Volume 5.

Fro m: Jason Samenow/DC/USEPA/US

To: Rona Birnbaum/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA

Cc: Ben DeAngelo/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Bill Perkins <perkins.william@epa.gov>, Lesley Jantarasami/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA

Dat e: 11/28/2009 11:38 AM

Subj vol 5 (use this version, please)

ect:

Sorry for multiple emails on this....but please refer to this version of Volume 5.
Jason

(Ben and Mike, please check the first comment and response on air quality and make sure both of your edits to that one were appropriately incorporated)

[attachment "RTC_draft_Volume_5_complete_1128.doc" deleted by Darrell Winner/DC/USEPA/US]

EPA-2564

Marcus Sarofim/DC/USEPA/US
12/01/2009 09:37 PM

To Bill Irving, Reid Harvey
cc
bcc
Subject Entire Comment Section from RTC

There was a note from Dina on sharing "this comment" with the two of you - it wasn't clear if it just referred to just the first comment in the section, or the entire section. In any case, here's the whole things...

-Marcus

4.2 Future Projections of Greenhouse Gas Emissions and Concentrations

Comment:

(b)(5) Deliberative

(b)(5) Deliberative

Response:

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

(b)(5) Deliberative

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

(b)(5) Deliberative

.

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

[redacted]

Comment:

(b)(5) Deliberative

[redacted]

Response:

(b)(5) Deliberative

[redacted]

Comment:

(b)(5) Deliberative

[redacted]

Response:

(b)(5) Deliberative

(b)(5) Deliberative

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

EPA-2565

Ben DeAngelo
04/06/2010 04:56 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\owner\My Documents\Endangerment\Response to Public Comments\RTC Vol 5 120109 -jh1201 5.2.doc

(b)(5) Deliberative [redacted] - RTC Vol 5 120109 -jh1201 5.2.doc

EPA-2566

Jason Samenow/DC/USEPA/US
12/01/2009 09:47 PM

To Ben DeAngelo
cc Jeremy Martinich, William Perkins
bcc
Subject support of use of precautionary principle

Ben-- Here are a couple comments supporting our use of the precautionary principle and the Finding. They were sent to me as Volume comments on uncertainty, but I think these are probably volume 9 comments. Can you dump these in? May just be able to combine with existing comments.

Thanks,
Jason

----- Forwarded by Jason Samenow/DC/USEPA/US on 12/01/2009 09:43 PM -----

From: William Perkins/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA
Cc: Jeremy Martinich/DC/USEPA/US@EPA
Date: 11/12/2009 04:36 PM
Subject: New 4.3 level of certainty

(b)(5) Deliberative

4_3_Level of Proof or Uncertainty.doc

Bill Perkins
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Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

EPA-2567

Michael Kolian
05/12/2010 10:11 AM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\Owner\My Documents\Ccd\TSD comment period\RTC Document and Outline\Volume 6\December\RTC draft Volume 6 Ag only 112809 LJ edits.doc

(b)(5) Deliberative [redacted] - RTC draft Volume 6 Ag only 112809 LJ edits.doc

EPA-2568

Lesley Jantarasami
04/01/2010 03:51 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\02_Comments and Responses\Vol 6 stuff\References_vol 6.doc

(b)(5) Deliberative - References_vol 6.doc

EPA-2569

William Perkins/DC/USEPA/US
12/01/2009 10:13 PM

To Rona Birnbaum, Lesley Jantarasami, Erin Birgfeld, Stacy Kika
cc
bcc
Subject For review: Endangerment timeline for OPA 1-page graphic

All,

As discussed, and building upon what Carole did for the website, enclosed is a draft timeline for your review. If you can get me any comments by late morning tomorrow, I can get this off to our contractor to format it into a nice timeline graphic and turned by the afternoon for us to get up to OAR. Thank you.

Cheers,

Bill

(b)(5) Deliberative

Endangerment timeline.doc

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(C) (b)(6)

EPA-2570

Marcus Sarofim/DC/USEPA/US
12/01/2009 10:31 PM

To David Chalmers
cc
bcc
Subject 4.1 and 4.2!!!

(b)(5) Deliberative

RTC draft Volume 4.1 and 4.2 + DINA-mcs.doc

Note that there is one additional reference here, and a few comments scattered throughout for OGC and other cross-walk issues that should stay in the document.

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

EPA-2571

Lesley Jantarasami
04/01/2010 03:51 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\ljantara\My Documents\Endangerment\02_Comments and Responses\Vol 6 stuff\RTC_draft_Volume_6_Forestry_only 120109 BJD MK.doc

(b)(5) Deliberative - RTC_draft_Volume_6_Forestry_only 120109 BJD MK.doc

EPA-2572

David Chalmers/DC/USEPA/US
12/01/2009 11:00 PM

To Rona Birnbaum, Lesley Jantarasami
cc William Perkins, Marcus Sarofim
bcc
Subject Vol. 4!!!

Rona: Please find the latest version of volume 4 attached. Sections 3-7 have gone through OGC review; sections 1-2 have not. I'm also attaching sections 1-2 in a separate document in case you'd like to send them to OGC as a separate file.

Lesley: This should be ready for OGC. Aside from all the normal things they do, can you please ask them to ensure that all the references from within the volume appear in the reference list and to clean up the formatting in the reference list?

Many thanks to Marcus for crashing through 4.1 and 4.2; they were beastly.

Thanks,
David

(b)(5) Deliberative

RTC draft Volume 4 MASTER 120109.doc

(b)(5) Del berative

RTC draft Volume 4.1 and 4.2 + DINA-mcs 120109.doc

EPA-2573

Jason Samenow/DC/USEPA/US
12/01/2009 11:02 PM

To Jeremy Martinich
cc
bcc
Subject Fw: supportive comments for vols 2 and 4

jeremy--
should probably add this supportive comment in the ocean acidification volume

Ocean Acidification

(b)(5) Deliberative

----- Forwarded by Jason Samenow/DC/USEPA/US on 12/01/2009 11:02 PM -----

From: Lesley Jantarasami/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA
Date: 11/23/2009 06:23 PM
Subject: supportive comments for vols 2 and 4

Fairly generic supportive comments for vols 2 and 4. It's up to you how you want to combine or break them out into separate summaries.

(b)(5) Deliberative

Supportive Comments for Vols 2 and 4.doc

Thanks,

Lesley

EPA-2574

William Perkins/DC/USEPA/US
12/01/2009 11:03 PM

To David Chalmers
cc
bcc
Subject Re: Vol. 4!!!

David,

Congratulations!

Cheers,

Bill

Bill Perkins
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(F) 202.343.2202
(C) (b)(6)

David Chalmers Rona: Please find the latest version o... 12/01/2009 11:00:27 PM

From: David Chalmers/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA
Cc: William Perkins/DC/USEPA/US@EPA, Marcus Sarofim/DC/USEPA/US@EPA
Date: 12/01/2009 11:00 PM
Subject: Vol. 4!!!

Rona: Please find the latest version of volume 4 attached. Sections 3-7 have gone through OGC review; sections 1-2 have not. I'm also attaching sections 1-2 in a separate document in case you'd like to send them to OGC as a separate file.

Lesley: This should be ready for OGC. Aside from all the normal things they do, can you please ask them to ensure that all the references from within the volume appear in the reference list and to clean up the formatting in the reference list?

Many thanks to Marcus for crashing through 4.1 and 4.2; they were beastly.

Thanks,
David

[attachment "RTC draft Volume 4 MASTER 120109.doc" deleted by William Perkins/DC/USEPA/US]
[attachment "RTC draft Volume 4.1 and 4.2 + DINA-mcs 120109.doc" deleted by William Perkins/DC/USEPA/US]

EPA-2575

William Perkins/DC/USEPA/US
12/01/2009 11:19 PM

To Sue Eisenfeld, Matthew Mitchell
cc Lesley Jantarasami, Mae Thomas
bcc
Subject Volume 4 for copyedit/formatting

Sue and Matt,

As discussed -- this one is a pretty good size at 80 pages. As you did for Volume 5, please do not put in comment numbers yet, but please of course do put in the lines between comment/response sets. Also, we do need you to do the same reference check (ensuring that all references appear in the reference list and formatting properly) on this volume as you did on the last several -- there are a lot of references in this volume but not as many as on some of the others. Please do not hesitate to contact Lesley and me if you have any questions and thank you.

Cheers,

Bill

(b)(5) Deliberative

RTC draft Volume 4 to ERG 120109.doc

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EPA-2576

Marcus Sarofim
04/01/2010 08:01 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\msarofim\My Documents\WorkFolder\Tsd_Anpr\ResponseToComments\Volumes\RTC draft Volume 4.1 and 4.2 + DINA-mcs.doc

(b)(5) Deliberative - RTC draft Volume 4.1 and 4.2 + DINA-mcs.doc

EPA-2578

Rona Birnbaum/DC/USEPA/US
12/02/2009 12:03 AM

To Carol Holmes, John Hannon, Dina Kruger
cc Suzanne Kocchi, Marcus Sarofim, David Chalmers, Lesley Jantarasami
bcc
Subject Fw: Vol. 4!!!

...first one that is described as "beastly".
----- Forwarded by Rona Birnbaum/DC/USEPA/US on 12/01/2009 11:59 PM -----

From: David Chalmers/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA
Cc: William Perkins/DC/USEPA/US@EPA, Marcus Sarofim/DC/USEPA/US@EPA
Date: 12/01/2009 11:00 PM
Subject: Vol. 4!!!

Rona: Please find the latest version of volume 4 attached. Sections 3-7 have gone through OGC review; sections 1-2 have not. I'm also attaching sections 1-2 in a separate document in case you'd like to send them to OGC as a separate file.

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Thanks,
David

(b)(5) Deliberative
RTC draft Volume 4 MASTER 120109.doc

(b)(5) Deliberative
RTC draft Volume 4.1 and 4.2 + DINA-mcs 120109.doc

EPA-2579

Rona Birnbaum/DC/USEPA/US
12/02/2009 12:14 AM

To Ben DeAngelo
cc Erin Birgfeld, Lesley Jantarasami, Stacy Kika, William Perkins
bcc
Subject Re: For review: Endangerment timeline for OPA 1-page graphic

Ben would be good if you had a quick look too.
thanks, Rona

Rona Birnbaum | looks good. some minor comments... R... | 12/02/2009 12:12:29 AM

From: Rona Birnbaum/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA
Cc: Erin Birgfeld/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA
Date: 12/02/2009 12:12 AM
Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

looks good. some minor comments...

(b)(5) Deliberative

Endangerment timeline.RB comments.doc

Rona Birnbaum
Chief, Climate Science and Impacts Branch
USEPA, Climate Change Division
birnbaum.rona@epa.gov
202-343-9076

William Perkins | All, As discussed, and building upon wh... | 12/01/2009 10:13:29 PM

From: William Perkins/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Erin Birgfeld/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA
Date: 12/01/2009 10:13 PM
Subject: For review: Endangerment timeline for OPA 1-page graphic

All,

As discussed, and building upon what Carole did for the website, enclosed is a draft timeline for your review. If you can get me any comments by late morning tomorrow, I can get this off to our contractor to format it into a nice timeline graphic and turned by the afternoon for us to get up to OAR. Thank you.

Cheers,

Bill

[attachment "Endangerment timeline.doc" deleted by Rona Birnbaum/DC/USEPA/US]

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EPA-2580

William Perkins/DC/USEPA/US
12/02/2009 12:26 AM

To Mae Thomas
cc
bcc Lesley Jantarasami
Subject Ongoing ERG task list 12/1

Mae,

Here is what I am tracking for outstanding tasks; please let me know if anything looks inaccurate. Thank you.

Cheers,

Bill

Task	Deadline	Status
Copyediting RTC Volumes 6,9 Wednesday	varies	1,2, 3,7, 8,10,11 done; 4,5 underway;
Final TSD copyedit turnaround	12/3	Giving to ERG evening of 12/2 for 24hr
Master reference list for docket (x2) references; ERG awaiting results of 2nd EPA review	12/4	1) Commenter submissions 2) EPA
Process new comments + supportives complete and matches everything received (access file given to EPA)	12/4	ensure that web interface is fully
Access file of web database info excerpts by category	12/4	also making pdfs of the category list + for all
Docketing RTC references copyrighted procedure (list and DVDs) underway for 12/4 send to docket	12/4	non-copyrighted uploaded immediately;
2nd round RTC copyedit	late week to weekend	
Docketing new TSD references (post-OMB) will be added later this week	complete for now	any additional new TSD references
Process memo to EPA	Draft complete	ERG awaiting EPA COR edits due 12/2
Comms material support midday; on call for early-to-mid week this week for other materials	12/2 + TBD	1 quick-turnaround task coming 12/2 by

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(C) (b)(6)

EPA-2581

Suzanne Kocchi/DC/USEPA/US
12/02/2009 07:40 AM

To Carol Holmes
cc Rona Birnbaum
bcc
Subject Re: latest preamble and to do list

I will be able to get you the preamble by 8:30 but it is ok if you want to start on vol 4. It is dense.
Carol Holmes

----- Original Message -----
From: Carol Holmes
Sent: 12/02/2009 07:09 AM EST
To: Suzanne Kocchi
Cc: Rona Birnbaum
Subject: Re: latest preamble and to do list

well -- I was going to ask for the preamble ASAP (b/c I woke up at 5 am thinking about it and couldn't get back to sleep which is why I am in the office now), but I just got volume 4, so I guess I should do that first? any thoughts? I hesitate only b/c the preamble needs to be done sooner than teh RTC, but review of the RTC often requires follow-up.

Confidential communication for internal deliberations only; Attorney-client, attorney work product and/or enforcement privilege; Do not distribute outside EPA or DOJ

Carol S. Holmes
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U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW (MC 2344A)
Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Suzanne Kocchi Ok. I have one thing from Ben to insert... 12/01/2009 10:21:04 PM

From: Suzanne Kocchi/DC/USEPA/US
To: Carol Holmes/DC/USEPA/US@EPA
Date: 12/01/2009 10:21 PM
Subject: Re: latest preamble and to do list

Ok. I have one thing from Ben to insert so do you want me to do it or do you want me to send to you to do?

Carol Holmes

----- Original Message -----
From: Carol Holmes
Sent: 12/01/2009 08:12 PM EST
To: Suzanne Kocchi
Cc: Ben DeAngelo; Dina Kruger; John Hannon; Rona Birnbaum
Subject: Re: latest preamble and to do list

I'll take the preamble tomorrow morning.

Confidential communication for internal deliberations only; Attorney-client, attorney work product and/or enforcement privilege; Do not distribute outside EPA or DOJ

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Office of General Counsel
U.S. Environmental Protection Agency
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Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Suzanne Kocchi Here is the latest To Do List and prea... 12/01/2009 06:08:25 PM

From: Suzanne Kocchi/DC/USEPA/US
To: Carol Holmes/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/01/2009 06:08 PM
Subject: latest preamble and to do list

Here is the latest To Do List and preamble. I've highlighted those still remaining. I carried out all of the assigned tasks to me. [redacted] (b)(5) Deliberative [redacted] highlighted where I made changes. The overview contains the OMB changes, the other highlights are my changes trying to carry out OMB changes throughout. [redacted] (b)(5) Deliberative [redacted]

Let me know who is taking this next. Looks like clearance on Friday so let's try to wrap up by Thur mid-afternoon so we have enough time to do the track changes/clean docs and submit to OMB so they can clear on Fri.

OMB 1: John (Done)
OMB 2: Carol
OMB 3: Ben
OMB 4: No action
OMB 5: Suzie (Done - Ben/Others should review highlights)
OMB 6: Suzie (Done)
OMB 7: Suzie (Done)
OMB 8: Ben
OMB 9: Carol
OMB 10: Suzie (Done)
OMB 11: Ben
OMB 12: John (Done- partially)
OMB 14: John (Done)
OMB 15: John (Done)
OMB 16: John (Done)
OMB 17: Suzie (Done)
OMB 18: John (Done)
OMB 19: Ben/Carol
OMB 20-22: John (Done)
OMB 23: John
OMB 24-26 John (Done)

Other edits:
[redacted] (b)(5) Deliberative [redacted]

(b)(5) Deliberative [redacted]

[attachment "Endangerment Findings Master_track changes _120109pm_jh+sk.doc" deleted by Carol Holmes/DC/USEPA/US]

Carol Holmes Thanks Suzie -- I had three more on m... 12/01/2009 10:04:47 AM

From: Carol Holmes/DC/USEPA/US
To: Suzanne Kocchi/DC/USEPA/US
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/01/2009 10:04 AM
Subject: Re: Fw: Please find attached a summary of additional interagency working comments under EO 12866

Thanks Suzie -- I had three more on my list (see below)

Confidential communication for internal deliberations only; Attorney-client, attorney work product and/or enforcement privilege; Do not distribute outside EPA or DOJ

Carol S. Holmes
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW (MC 2344A)
Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Suzanne Kocchi I will take the pen on the preamble no... 12/01/2009 09:56:27 AM

From: Suzanne Kocchi/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/01/2009 09:56 AM
Subject: Re: Fw: Please find attached a summary of additional interagency working comments under EO 12866

I will take the pen on the preamble now to do some of the minor editing. Next person who needs it, just let me know.

To do list as far as my notes go:

OMB 1: John (Done)
OMB 2: Carol
OMB 3: Ben
OMB 4: No action
OMB 5: Suzie to talk to Heidi today - Ben to do
OMB 6: Suzie
OMB 7: Suzie

OMB 8: Ben
OMB 9: Carol
OMB 10: Suzie
OMB 11: Ben
OMB 12: John (Done- partially)
OMB 13: John (Done - partially)
OMB 14: John
OMB 15: John
OMB 16: John
OMB 17: Suzie/Lesley
OMB 18: John
OMB 19: Ben/Carol
OMB 20-26: Suzie (John did some of these already, I think only 23 is left and I want to think about that).

Other edits:
(b)(5) Deliberative

John Hannon here is a revised version of the preambl... 12/01/2009 09:08:55 AM

From: John Hannon/DC/USEPA/US
To: Suzanne Kocchi/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/01/2009 09:08 AM
Subject: Re: Fw: Please find attached a summary of additional interagency working comments under EO 12866

here is a revised version of the preamble. It is what we had yesterday night plus responses to various OMB comments:

OMB 1 - I made changes to (b)(5) Deliberative

OMB 12, 13 (made changes where they noted, still need to check other places they did not note), 14 -16, 18, 20-22, 24 - 26.

(b)(5) Deliberative

One OMB/DOJ comment was (b)(5) Deliberative

[attachment "Endangerment Findings Master_track changes _113009pm -jh1201.doc" deleted by

Suzanne Kocchi/DC/USEPA/US]

John Hannon
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Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Suzanne Kocchi Quotes from DOJ that Heidi wants us t... 11/30/2009 06:08:10 PM

From: Suzanne Kocchi/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA
Date: 11/30/2009 06:08 PM
Subject: Fw: Please find attached a summary of additional interagency working comments under EO 12866

Quotes from DOJ that Heidi wants us to add.

----- Forwarded by Suzanne Kocchi/DC/USEPA/US on 11/30/2009 06:07 PM -----

From: "King, Heidi R." (b)(6)
To: Suzanne Kocchi/DC/USEPA/US@EPA
Cc: "Mancini, Dominic J." (b)(6)
Date: 11/30/2009 05:59 PM
Subject: RE: Please find attached a summary of additional interagency working comments under EO 12866

Suzie,

Attached is a summary of additional additional interagency comments!

I hope you have a good evening,

heidi

From: King, Heidi R.
Sent: Monday, November 30, 2009 12:09 PM
To: 'Kocchi.Suzanne@epamail.epa.gov'
Cc: Mancini, Dominic J.
Subject: Please find attached a summary of additional interagency working comments under EO 12866

Suzie,

Attached is a summary of additional interagency comments.

Best,

heidi

From: King, Heidi R.

Sent: Wednesday, November 25, 2009 4:09 PM
To: 'Kocchi.Suzanne@epamail.epa.gov'
Cc: Mancini, Dominic J.
Subject: Please find attached a summary of interagency working comments under EO 12866

Suzie,

Attached is a summary of the interagency comments received on EPA's draft language for the final Endangerment Finding. I expect that a few more comments may follow on Friday / Monday, and I will send them as soon as possible to allow you time to consider them.

Please contact me if you have any questions, and have a good holiday!

Best,

heidi[attachment "Summary of Interagency Working Comments under EO 12866_120109.pdf" deleted by John Hannon/DC/USEPA/US]

EPA-2582

Ben DeAngelo/DC/USEPA/US
12/02/2009 08:29 AM

To Erin Birgfeld
cc Lesley Jantarasami, Rona Birnbaum, Stacy Kika, William Perkins
bcc
Subject Re: For review: Endangerment timeline for OPA 1-page graphic

Some suggestions.

(b)(5) Deliberative

Endangerment timeline.RB BJD comments.doc

Erin Birgfeld looks great! Erin Birgfeld 12/02/2009 06:01:37 AM

From: Erin Birgfeld/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/02/2009 06:01 AM
Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

looks great!

Erin Birgfeld
Director of Communications
Climate Change Division
U.S. Environmental Protection Agency
phone: (202) 343-9079
fax: (202) 343-2202

-----Rona Birnbaum/DC/USEPA/US wrote: -----

To: Ben DeAngelo/DC/USEPA/US@EPA
From: Rona Birnbaum/DC/USEPA/US
Date: 12/02/2009 12:14AM
cc: Erin Birgfeld/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

Ben would be good if you had a quick look too.
thanks, Rona

Rona Birnbaum---12/02/2009 12:12:29 AM---looks good. some minor comments... Rona Birnbaum Chief, Climate Science and Impacts Branch

From: Rona Birnbaum/DC/USEPA/US

To: William Perkins/DC/USEPA/US@EPA

Cc: Erin Birgfeld/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy

Kika/DC/USEPA/US@EPA

Date: 12/02/2009 12:12 AM

Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

looks good. some minor comments...

Rona Birnbaum
Chief, Climate Science and Impacts Branch
USEPA, Climate Change Division
birnbaum.rona@epa.gov
202-343-9076

William Perkins---12/01/2009 10:13:29 PM---All, As discussed, and building upon what Carole did for the website, enclosed is a draft timeline f

From: William Perkins/DC/USEPA/US

To: Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Erin Birgfeld/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA

Date: 12/01/2009 10:13 PM

Subject: For review: Endangerment timeline for OPA 1-page graphic

All,

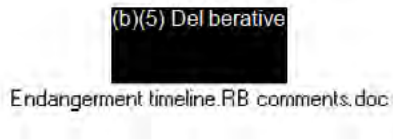
As discussed, and building upon what Carole did for the website, enclosed is a draft timeline for your review. If you can get me any comments by late morning tomorrow, I can get this off to our contractor to format it into a nice timeline graphic and turned by the afternoon for us to get up to OAR. Thank you.

Cheers,

Bill

[attachment "Endangerment timeline.doc" deleted by Rona Birnbaum/DC/USEPA/US]

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)


(b)(5) Del berative
Endangerment timeline.RB comments.doc

EPA-2583

David McIntosh/DC/USEPA/US
12/02/2009 08:47 AM

To oster.seth, mccarthy.gina, heinzerling.lisa, depass.michelle
cc
bcc
Subject sketch of a Copenhagen message

FYI, this is not really even the first draft of anything, but rather just a sketch of the kind of basic message I kind of have in mind for the Administrator personally in Copenhagen. I thouhg tit might be helpful for me to circulate it to this small group in advance of Seth's meeting this afternoon.

(b)(5) Deliberative

EPA-2584

Suzanne Kocchi/DC/USEPA/US
12/02/2009 09:19 AM

To
cc Ben DeAngelo, Carol Holmes, David Chalmers, Jason Samenow, Jeremy Martinich, John Hannon, Lesley Jantarasami, Marcus Sarofim, Michael Kolian, Rona Birnbaum, William Perkins
bcc
Subject Re: latest RTC tracking table

here it is as of wed morn

(b)(5) Deliberative

Review Table_Endangerment 120209.xls

EPA-2585

Carol Holmes/DC/USEPA/US
12/02/2009 09:53 AM

To Rona Birnbaum
cc David Chalmers, Dina Kruger, John Hannon, Lesley Jantarasami, Marcus Sarofim, Suzanne Kocchi
bcc
Subject Re: Fw: Vol. 4!!!

OK -- I'll review the excerpted version this morning, early afternoon.

Confidential communication for internal deliberations only; Attorney-client, attorney work product and/or enforcement privilege; Do not distribute outside EPA or DOJ

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Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Rona Birnbaum ...first one that is described as "beastly"... 12/02/2009 12:03:38 AM

From: Rona Birnbaum/DC/USEPA/US
To: Carol Holmes/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA
Cc: Suzanne Kocchi/DC/USEPA/US@EPA, Marcus Sarofim/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA
Date: 12/02/2009 12:03 AM
Subject: Fw: Vol. 4!!!

...first one that is described as "beastly".
----- Forwarded by Rona Birnbaum/DC/USEPA/US on 12/01/2009 11:59 PM -----

From: David Chalmers/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA
Cc: William Perkins/DC/USEPA/US@EPA, Marcus Sarofim/DC/USEPA/US@EPA
Date: 12/01/2009 11:00 PM
Subject: Vol. 4!!!

Rona: Please find the latest version of volume 4 attached. Sections 3-7 have gone through OGC review; sections 1-2 have not. I'm also attaching sections 1-2 in a separate document in case you'd like to send them to OGC as a separate file.

Lesley: This should be ready for ERG. Aside from all the normal things they do, can you please ask them to ensure that all the references from within the volume appear in the reference list and to clean up the formatting in the reference list?

Many thanks to Marcus for crashing through 4.1 and 4.2; they were beastly.

Thanks,
David

[attachment "RTC draft Volume 4 MASTER 120109.doc" deleted by Carol Holmes/DC/USEPA/US]
[attachment "RTC draft Volume 4.1 and 4.2 + DINA-mcs 120109.doc" deleted by Carol Holmes/DC/USEPA/US]

EPA-2586

David Chalmers/DC/USEPA/US
12/02/2009 10:02 AM

To Jason Samenow
cc Marcus Sarofim
bcc
Subject important response for quick review

Jason:

I made fairly significant revisions to our response to comments (b)(5) Deliberative based on a comment from Carol. Carol mentioned that she asked you about this, and she included a summary of the response you recommended. Since this is a hot button issue, it's important to ensure the response is solid. I don't think this volume is getting another full round of review, so can you please give the attached a quick but careful look (it's only a page) and let me know if a) the response seems fully consistent with everything in 2.2 b) captures your recommendations via Carol and c) adequately responds to the comment.

Marcus: Can you give it a quick glance as well?

Thanks

(b)(5) Deliberative

response for Jason and Marcus review.doc

EPA-2587

Ben DeAngelo
04/06/2010 04:56 PM

To
cc
bcc
Subject UPLOAD C:\Documents and Settings\owner\My Documents\Endangerment\Response to Public Comments\Review Table_Endangerment 120209.xls

(b)(5) Deliberative [redacted] - Review Table_Endangerment 120209.xls

EPA-2588

Michael Kolian/DC/USEPA/US
12/02/2009 10:17 AM

To Tracy Kolian
cc
bcc
Subject Fw: From Inside EPA

----- Forwarded by Michael Kolian/DC/USEPA/US on 12/02/2009 10:17 AM -----

From: Kevin Rosseel/DC/USEPA/US
To:
Date: 12/02/2009 08:22 AM
Subject: From Inside EPA

Obama's Endangerment Pledge?

A former Senate aide says speculation is growing that President Obama will announce the release of EPA's findings that greenhouse gas (GHG) emissions endanger the public during his much-anticipated Dec. 9 appearance at international climate talks in Copenhagen.

The announcement by Obama, according to the source, would be intended to demonstrate his commitment to achieving the emission reductions recently announced by his administration, despite Senate struggles to pass cap-and-trade legislation.

The Obama administration recently declared the U.S. is prepared to commit to absolute emission reductions “in the range of” 17 percent below 2005 levels by 2020, in line with a House-passed cap-and-trade bill.

But the source says with the Senate cap-and-trade bill faltering, announcing the GHG endangerment finding could demonstrate a credible vehicle to international partners by which Obama could achieve his climate policy goals. Further, the announcement would provide tangible movement to shield against any political fallout from his not securing a binding treaty at the climate talks, the source argues.

Observers recently said EPA may issue the endangerment finding in time for Copenhagen, but the speculation is now focusing on whether President Obama himself will announce the findings, the source says.

By announcing the findings, which will lead to GHG emission regulations under the Clean Air Act, Obama could change the tenor of the debate by focusing it away from legislation and toward an initial regulatory strategy. The Obama administration has steadfastly proclaimed its preference for cap-and-trade legislation to this point.

EPA Nov. 6 sent the draft endangerment finding to the White House Office of Management & Budget for approval.

Posted 12/1/2009
.....
Kevin Rosseel
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
Washington, DC 20460

202 343-9731

EPA-2589

Lesley Jantarasami/DC/USEPA/US
12/02/2009 10:22 AM

To Mike Kolian
cc
bcc
Subject Fw: Vol 8 with RB comments

----- Forwarded by Lesley Jantarasami/DC/USEPA/US on 12/02/2009 10:22 AM -----

From: Rona Birnbaum/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA
Date: 12/01/2009 11:58 PM
Subject: Vol 8 with RB comments

Bill, looks good but with a few suggestions where examples would make the response stronger plus a few important spots where I'd like Ben to check for consistency with the national security language. Also for Ben, there is a comment at the end which references one of the petitions for rulemaking...have a look to make sure we send them to the right spot in the Findings.

(b)(5) Deliberative

RTC draft Volume 8 120109.RB comments.doc

EPA-2590

John Hannon/DC/USEPA/US
12/02/2009 10:30 AM

To John Hannon
cc Ben DeAngelo, Carol Holmes, Michael Kolian
bcc
Subject Re: The latest Volume 5

I took a cut at adding more text to the preamble re ozone, using text that I suggest we add to the RTC, e.g.p68. I also tweaked the text some f from the sentence in the RTC I sent last night.

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative
AQ insert re ozone - jh1202.doc

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Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

John Hannon Ben and Michael, here are my edits to... 12/01/2009 08:44:30 PM

From: John Hannon/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA
Date: 12/01/2009 08:44 PM
Subject: Re: The latest Volume 5

Ben and Michael, here are my edits to the AQ part of vol 5, 5.2. I tried to bring in more of the ideas about the balancing of increases versus decreases in ozone, and suggest one place where we could insert Fig 3-11 from the IA. I added various comment balloons, but they just get added in with the prior comment balloons.

[attachment "RTC Vol 5 120109 -jh1201 5.2.doc" deleted by John Hannon/DC/USEPA/US] .

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Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Ben DeAngelo There's still work to be done (not a hug... 12/01/2009 06:41:57 PM

From: Ben DeAngelo/DC/USEPA/US
To: Dina Kruger/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 06:41 PM
Subject: Re: The latest Volume 5

There's still work to be done (not a huge amount) on the AQ section within 5, so there's plenty of material in 5 you can work through before getting to AQ. So we might have these issues resolved before you get to review AQ within 5 -- in that case we could reinsert that section.

Dina Kruger Based on the email chain, I'm wonderin... 12/01/2009 06:36:28 PM

From: Dina Kruger/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 06:36 PM
Subject: Re: The latest Volume 5

Based on the email chain, I'm wondering if I should turn to Vol 5 when I finish with 11, or wait until John and Ben finish up. Is it still a work in progress (at least in part)? I don't want to create a version control issue. Thanks -

Dina

Sent by EPA Wireless E-Mail Services

Ben DeAngelo

----- Original Message -----
From: Ben DeAngelo
Sent: 12/01/2009 03:56 PM EST
To: John Hannon
Cc: Carol Holmes; David Chalmers; Dina Kruger; Jason Samenow; Lesley Jantarasami; Michael Kolian; Rona Birnbaum; Suzanne Kocchi; William Perkins
Subject: Re: The latest Volume 5

Here's the underlying IA. Am continuing to work on ag for now.

[attachment "GCAQ report 4-8-09.pdf" deleted by Dina Kruger/DC/USEPA/US]

John Hannon This is the e-mail I just sent him on that:... 12/01/2009 03:38:38 PM

From: John Hannon/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:38 PM
Subject: Re: The latest Volume 5

This is the e-mail I just sent him on that:

Ben, could you send me the IA? The insert refers to a Table from it.

A quick reaction to the insert:

(b)(5) Deliberative

I still have a lot of questions on this, we should talk..

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Rona Birnbaum hi John, I believe Ben sent you an emai... 12/01/2009 03:16:40 PM

From: Rona Birnbaum/DC/USEPA/US
To: John Hannon/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David

Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:16 PM
Subject: Re: The latest Volume 5

hi John, I believe Ben sent you an email earlier today that pulled that out for you to have a look. see if that helps.

thanks, Rona

John Hannon Since this is not in RLSO, is there a wa... 12/01/2009 03:00:40 PM

From: John Hannon/DC/USEPA/US
To: Jason Samenow/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/01/2009 03:00 PM
Subject: Re: The latest Volume 5

Since this is not in RLSO, is there a way to quickly point me to the new ozone stuff?

John Hannon
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Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Jason Samenow We've made quite a few edits to Volu... 12/01/2009 11:03:57 AM

From: Jason Samenow/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA, Michael Kolian/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA
Date: 12/01/2009 11:03 AM
Subject: The latest Volume 5

We've made quite a few edits to Volume 5 to respond to John's comments (b)(5) Deliberative [redacted] There are undoubtedly still unresolved issues to work through, but this is getting closer. Comment bubbles remain in the margins where we have issues to address (though it's possible in a few cases we actually addressed the comment but neglected to delete the bubble).

Please find the Volume attached.

Thanks for everyone's collective efforts on working through this challenging, and lengthy volume.

Jason

EPA-2591

Lesley Jantarasami/DC/USEPA/US
12/02/2009 10:32 AM

To Michael Kolian
cc Marcus Sarofim
bcc
Subject Re: vol 3

I agree with Marcus that the MWP and treeline comment would make sense in Section 2.6 - changes in biological systems. I will make that move since I hold the pen on both those sections.

Shouldn't this comment 3217.1 below go into Section 2.1 Observed Greenhouse Gas Emissions?

Michael Kolian Boy, I don't know where 3217.1 went..... 12/02/2009 10:14:54 AM

From: Michael Kolian/DC/USEPA/US
To: Marcus Sarofim/DC/USEPA/US@EPA
Cc: Lesley Jantarasami/DC/USEPA/US@EPA
Date: 12/02/2009 10:14 AM
Subject: Re: vol 3

Boy, I don't know where 3217.1 went.....

It's not in vol 5 or 6. So process of elimination leaves - vol 9 or 8 as likely and 1,3,7 as doubtful but possible.

Marcus Sarofim Er. Maybe Volume 2 would actually be... 12/01/2009 09:29:43 PM

From: Marcus Sarofim/DC/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Cc: David Chalmers/DC/USEPA/US@EPA
Date: 12/01/2009 09:29 PM
Subject: Re: vol 3

Er. Maybe Volume 2 would actually be better, in terms of dealing with past changes like tree-line shifts in the MWP.

Mike: I came across this comment in Volume 4, with no response except "see Volume 10". Volume 10 (or 11, or 2) doesn't seem to have this comment, but I _know_ that you wrote a response to this because you asked me about it - do you know what volume your response might have ended up in?

(b)(5) Deliberative

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

Michael Kolian Marcus, Do you either have this comm... 12/01/2009 06:26:38 PM

From: Michael Kolian/DC/USEPA/US
To: Marcus Sarofim/DC/USEPA/US@EPA
Cc: David Chalmers/DC/USEPA/US@EPA
Date: 12/01/2009 06:26 PM
Subject: vol 3

Marcus,
Do you either have this comment in vol 3 or it is reasonable to refer the commenter to vol 3? I believe the primary assertion is about evidence of non-anthropogenic GHG-induced climate change.

Comment:

(b)(5) Deliberative

Response:

(b)(5) Deliberative

EPA-2592

Stacy Kika/DC/USEPA/US
12/02/2009 10:32 AM

To Ben DeAngelo
cc Erin Birgfeld, Lesley Jantarasami, Rona Birnbaum, William Perkins
bcc
Subject Re: For review: Endangerment timeline for OPA 1-page graphic

I just made a minor edit, can take or leave it. But I just thought to make it consistent with the other comment period and to make sure there is no confusion. Overall looks good!

(b)(5) Deliberative

Endangerment timeline-shk.doc

Thanks.

Stacy

~~~~~~~~~~~~~~~~~~~~~~

Stacy H. Kika
U.S. Environmental Protection Agency
Climate Change Division- Communications
Email: kika.stacy@epa.gov
Phone: 202.343.9930

Ben DeAngelo Some suggestions. 12/02/2009 08:29:14 AM

From: Ben DeAngelo/DC/USEPA/US
To: Erin Birgfeld/DC/USEPA/US@EPA
Cc: Lesley Jantarasami/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/02/2009 08:29 AM
Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

Some suggestions.

[attachment "Endangerment timeline.RB BJD comments.doc" deleted by Stacy Kika/DC/USEPA/US]

Erin Birgfeld looks great! Erin Birgfeld 12/02/2009 06:01:37 AM

From: Erin Birgfeld/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Date: 12/02/2009 06:01 AM
Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

looks great!

Erin Birgfeld
Director of Communications
~~~~~~~~~~~~~~~~~~~~~~

Climate Change Division
U.S. Environmental Protection Agency
phone: (202) 343-9079
fax: (202) 343-2202

-----Rona Birnbaum/DC/USEPA/US wrote: -----

To: Ben DeAngelo/DC/USEPA/US@EPA
From: Rona Birnbaum/DC/USEPA/US
Date: 12/02/2009 12:14AM
cc: Erin Birgfeld/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA, William Perkins/DC/USEPA/US@EPA
Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

Ben would be good if you had a quick look too.
thanks, Rona

Rona Birnbaum---12/02/2009 12:12:29 AM---looks good. some minor comments... Rona Birnbaum Chief, Climate Science and Impacts Branch

From: Rona Birnbaum/DC/USEPA/US

To: William Perkins/DC/USEPA/US@EPA

Cc: Erin Birgfeld/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA

Date: 12/02/2009 12:12 AM

Subject: Re: For review: Endangerment timeline for OPA 1-page graphic

looks good. some minor comments...

Rona Birnbaum
Chief, Climate Science and Impacts Branch
USEPA, Climate Change Division
birnbaum.rona@epa.gov
202-343-9076

William Perkins---12/01/2009 10:13:29 PM---All, As discussed, and building upon what Carole did for the website, enclosed is a draft timeline f

From: William Perkins/DC/USEPA/US

To: Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Erin Birgfeld/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA

Date: 12/01/2009 10:13 PM

Subject: For review: Endangerment timeline for OPA 1-page graphic

All,

As discussed, and building upon what Carole did for the website, enclosed is a draft timeline for your review. If you can get me any comments by late morning tomorrow, I can get this off to our contractor to format it into a nice timeline graphic and turned by the afternoon for us to get up to OAR. Thank you.

Cheers,

Bill

[attachment "Endangerment timeline.doc" deleted by Rona Birnbaum/DC/USEPA/US]

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

[attachment "Endangerment timeline RB comments.doc" deleted by Stacy Kist/DC/USEPA/US]

EPA-2593

"Sue Eisenfeld" <Sue.Eisenfeld@erg.com>
12/02/2009 10:54 AM

To William Perkins
cc
bcc
Subject Re: Volume 4 for copyedit/formatting

Ok, just wanted to check. Thanks.

Sue Eisenfeld
ERG
Director of Editorial and Video Services
2300 Wilson Blvd., Suite 350
Arlington, VA 22201
P: 703-841-0504
F: 703-841-1440
I am usually in the office M, W, F

>>> <Perkins.William@epamail.epa.gov> 12/2/2009 10:53 AM >>>
Sue,

It should actually be "dimers" -- Marcus noted that he thinks he defined the term also since it is unusual.

Cheers,

Bill

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

From: "Sue Eisenfeld" <Sue.Eisenfeld@erg.com>

To: William Perkins/DC/USEPA/US@EPA

Cc: Lesley Jantarasami/DC/USEPA/US@EPA, "Mae Thomas" <Mae.Thomas@erg.com>

Date: 12/02/2009 10:50 AM

Subject: Re: Volume 4 for copyedit/formatting

Should 'water vapor dimers' actually be 'water vapor dimmers'? Related to dimming? (to dim). With one 'm,' this would be pronounced like "dime"-ers.

Sue Eisenfeld
ERG
Director of Editorial and Video Services
2300 Wilson Blvd., Suite 350
Arlington, VA 22201
P: 703-841-0504
F: 703-841-1440
I am usually in the office M, W, F

>>> <Perkins.William@epamail.epa.gov> 12/1/2009 11:19 PM >>>

Sue and Matt,

As discussed -- this one is a pretty good size at 80 pages. As you did for Volume 5, please do not put in comment numbers yet, but please of course do put in the lines between comment/response sets. Also, we do need you to do the same reference check (ensuring that all references appear in the reference list and formatting properly) on this volume as you did on the last several -- there are a lot of references in this volume but not as many as on some of the others. Please do not hesitate to contact Lesley and me if you have any questions and thank you.

Cheers,

Bill

(See attached file: RTC draft Volume 4 to ERG 120109.doc)

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(F) 202.343.2202
(C) (b)(6)

EPA-2594

Rona Birnbaum/DC/USEPA/US
12/02/2009 11:10 AM

To Jeremy Martinich
cc
bcc
Subject Fw: Volume 1

part of Vol 1. Can you send me and Suzie the latest latest so she can she that...

----- Forwarded by Rona Birnbaum/DC/USEPA/US on 12/02/2009 11:09 AM -----

From: Dina Kruger/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA
Date: 12/02/2009 10:57 AM
Subject: Volume 1

Here is the beginning of this, up to subsection 1.1.2. [redacted] (b)(5) Deliberative

[redacted]

(b)(5) Del berative

RTC draft Volume 1 General TSD Approach +DINA 12-01-09.doc

Dina Kruger
Director, Climate Change Division
USEPA

202-343-9039 (phone)
202-343-2290 (fax)

EPA-2595

Jason Samenow/DC/USEPA/US
12/02/2009 11:22 AM

To Ben DeAngelo
cc
bcc
Subject optimal climate issue

Not sure what happened with this comment/response, but it might not have ever been moved to 9 but it's also no longer in 1.

Some of the points in here may not be relevant or addressed elsewhere, but think (b)(5) Deliberative [redacted]

In addition to the commenter mentioned here, CEI (comment # 3316.1ANPRref1) also states:

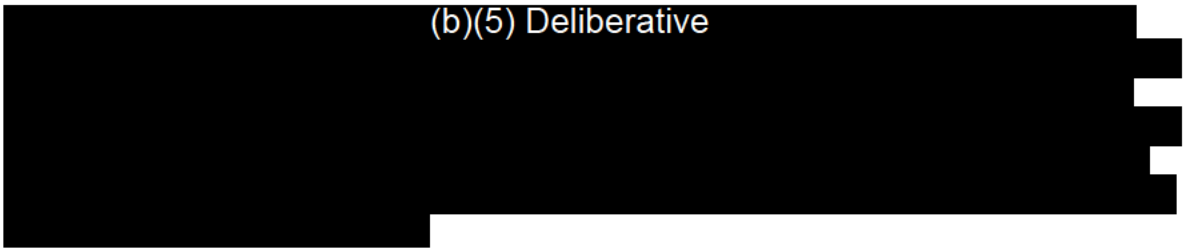
"...recall that Northern Hemisphere temperatures were significantly warmer than they are today during a period lasting from about 4,000 to 11,000 years ago (cites IPCC). Traditional climate historians called that period the Holocene "optimum," believing it to have been the best climate for human civilization.

Comment:

(b)(5) Deliberative [redacted]

Response:

(b)(5) Deliberative [redacted]


(b)(5) Deliberative

EPA-2596

William Perkins/DC/USEPA/US
12/02/2009 11:30 AM

To "Sue Eisenfeld"
cc Lesley Jantarasami, "Mae Thomas"
bcc
Subject Re: Volume 4 for copyedit/formatting

Yes, that is correct.

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

"Sue Eisenfeld" Just wanted to check that the unit here... 12/02/2009 11:08:07 AM

From: "Sue Eisenfeld" <Sue.Eisenfeld@erg.com>
To: William Perkins/DC/USEPA/US@EPA
Cc: Lesley Jantarasami/DC/USEPA/US@EPA, "Mae Thomas" <Mae.Thomas@erg.com>
Date: 12/02/2009 11:08 AM
Subject: Re: Volume 4 for copyedit/formatting

Just wanted to check that the unit here is watts?
estimated total geothermal heat flowing out of the Earth to be about 4.2 x 10^{13} W – or about 80 milliW/m^2

Sue Eisenfeld
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Director of Editorial and Video Services
2300 Wilson Blvd., Suite 350
Arlington, VA 22201
P: 703-841-0504
F: 703-841-1440
I am usually in the office M, W, F

>>> <Perkins.William@epamail.epa.gov> 12/1/2009 11:19 PM >>>

Sue and Matt,

As discussed -- this one is a pretty good size at 80 pages. As you did for Volume 5, please do not put in comment numbers yet, but please of course do put in the lines between comment/response sets. Also, we do need you to do the same reference check (ensuring that all references

appear in the reference list and formatting properly) on this volume as you did on the last several -- there are a lot of references in this volume but not as many as on some of the others. Please do not hesitate to contact Lesley and me if you have any questions and thank you.

Cheers,

Bill

(See attached file: RTC draft Volume 4 to ERG 120109.doc)

Bill Perkins
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(F) 202.343.2202
(C) (b)(6)

EPA-2597

Marcus Sarofim/DC/USEPA/US
12/02/2009 11:30 AM

To Michael Kolian
cc Lesley Jantarasami
bcc
Subject Re: Fw: GHGs comment 3217.1

I did include comment 3217.1 in Volume 4, with a comment bubble noting a possible move, and included the first half of the response below (ending just before the "In addition, research by Archer...")

However, I will also note that Dina left a little comment noting that [redacted] (b)(5) Deliberative [redacted] in the TSD:

1. [redacted] (b)(5) Deliberative [redacted]
2. [redacted] (b)(5) Deliberative [redacted]

I think the draft response below addresses Dina's comment 2, though maybe we can do a better direct reference to the Findings on [redacted] (b)(5) Deliberative [redacted]. I just suggested an edit to the TSD to Jason for including the statement: [redacted] (b)(5) Deliberative [redacted] but in emissions projections, not in historical emissions... but we can reference that if it makes it in.

-Marcus

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

Michael Kolian I believe we left off with this response..... 12/02/2009 10:51:37 AM

From: Michael Kolian/DC/USEPA/US
To: Marcus Sarofim/DC/USEPA/US@EPA
Cc: Lesley Jantarasami/DC/USEPA/US@EPA
Date: 12/02/2009 10:51 AM
Subject: Fw: GHGs comment 3217.1

I believe we left off with this response.....

[redacted] (b)(5) Deliberative [redacted]

(b)(5) Deliberative

----- Forwarded by Michael Kolian/DC/USEPA/US on 12/02/2009 10:49 AM -----

From: Michael Kolian/DC/USEPA/US
To: Marcus Sarofim/DC/USEPA/US@EPA
Date: 09/23/2009 10:35 AM
Subject: Re: GHGs comment

Great. Thanks!

Marcus Sarofim (b)(5) Deliberative 09/23/2009 10:24:40 AM

From: Marcus Sarofim/DC/USEPA/US
To: Michael Kolian/DC/USEPA/US@EPA
Date: 09/23/2009 10:24 AM
Subject: Re: GHGs comment

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

Marcus C. Sarofim, PhD
phone: 202-343-9993
fax: 202-343-2202
1310 L Street 256C
AAAS Science & Technology Policy Fellow
with the EPA Climate Division

Michael Kolian Marcus, Wondered if you came across... 09/23/2009 09:32:37 AM

From: Michael Kolian/DC/USEPA/US
To: Marcus Sarofim/DC/USEPA/US@EPA
Date: 09/23/2009 09:32 AM
Subject: GHGs comment

Marcus,
Wondered if you came across a similar comment in your GHG categories? Also, can you look at the response. This is currently in validity of observed/measured data.
Cheers,
Mike

Comment: (b)(5) Deliberative

[redacted]

Response: (b)(5) Deliberative

[redacted]

(b)(5) Deliberative

EPA-2598

Michael Kolian/DC/USEPA/US
12/02/2009 11:36 AM

To William Perkins, Jason Samenow, David Chalmers
cc Rona Birnbaum
bcc
Subject vulnerable pop, EJ, and public health

I think we (b)(5) Deliberative

1) We may want to consider seeing how we can highlight these issues in the General Section of volume 5 and referring to volume 8 (which may not due very much) and noting the overlap.

2) I think this is a great response in vol 8 which we should highlight up front somewhere with additional examples.

Jason, what's the path forward for continuing to revise parts of vol 5? I don't think shoring up this relationship will require that much work.....

Comment (8-xx):
(b)(5) Deliberative

Response (8-xx):
(b)(5) Deliberative

(b)(5) Deliberative

[redacted]

EPA-2599

Jason Samenow/DC/USEPA/US
12/02/2009 11:40 AM

To Michael Kolian
cc David Chalmers, Rona Birnbaum, William Perkins
bcc
Subject Re: vulnerable pop, EJ, and public health

if you can draft a general comment/response on vulnerables to insert in vol 5, that would be great. dina is still reviewing, and we won't get it back until tomorrow. i can put it in then.

thanks...

jason

Michael Kolian I think (b)(5) Deliberative 12/02/2009 11:36:26 AM

From: Michael Kolian/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA
Cc: Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 11:36 AM
Subject: vulnerable pop, EJ, and public health

I think (b)(5) Deliberative

1) We may want to consider seeing how we can highlight these issues in the General Section of volume 5 and referring to volume 8 (which may not due very much) and noting the overlap.

2) I think this is a great response in vol 8 which we should highlight up front somewhere with additional examples.

Jason, what's the path forward for continuing to revise parts of vol 5? I don't think shoring up this relationship will require that much work.....

Comment (8-xx):

(b)(5) Deliberative

Response (8-xx):

(b)(5) Deliberative

EPA-2600

"Tracy Parham"
<Tracy.Parham@erg.com>
12/02/2009 11:56 AM

To Lesley Jantarasami
cc "Mae Thomas", "Tracy Parham"
bcc
Subject Volume 11, Comment 11-22

Lesley,

1. Regarding Comment (11-22), (b)(5) Deliberative

2. In searching through supportive and ANPR comments incorporated by reference, I have found several comments in which the commenter supports (b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

(b)(5) Deliberative

Please call if you have any questions or concerns.

Thanks,
Tracy

Tracy DeHaven Parham
Environmental Scientist

Eastern Research Group, Inc.
1600 Perimeter Park Drive
Morrisville, NC 27560
(919)-468-7901 (phone)
(919)-468-7801 (fax)

EPA-2601

Carol Holmes/DC/USEPA/US
12/02/2009 11:57 AM

To John Hannon, Dina Kruger, Suzanne Kocchi, Ben DeAngelo, Rona Birnbaum
cc Patricia Embrey, Joseph Goffman, Lydia Wegman
bcc
Subject Press from CBD w/ petition

For Immediate Release, December 2, 2009

Contacts: Kassie Siegel, Center for Biological Diversity, (760) 366-2232 x 302, ksiegel@biologicaldiversity.org
Bill McKibben, 350.org, bill@350.org

EPA Petitioned to Cap Carbon Dioxide Pollution at 350 Parts Per Million Under the Clean A

WASHINGTON— The Center for Biological Diversity and 350.org today petitioned the Environmental Protection Agency to set r carbon dioxide and other greenhouse gas pollution under the Clean Air Act. The petition seeks to have greenhouse gases desig "criteria" air pollutants and atmospheric CO2 capped at 350 parts per million (ppm), the level leading scientists say is necessary worst impacts of global warming.

"It's time to use our strongest existing tool for reducing greenhouse gas pollution — the Clean Air Act. The Act's provisions shou pollution at no more than 350 parts per million," said Kassie Siegel, an author of the petition and director of the Center for Biolog Climate Law Institute. "For four decades, this law has protected the air we breathe — and it's done that through a proven, succe pollution control that saves lives and creates economic benefits vastly exceeding its costs."

Last week, in advance of the international climate negotiations in Copenhagen, the Obama administration proposed emissions r of just 3 percent below 1990 levels by 2020, far below the cuts of approximately 45 percent necessary to get back to 350 ppm. T atmospheric CO2 level is approximately 385 ppm.

The administration argues that its hands are tied by the weak cap-and-trade bills passed by the House of Representatives and u consideration by the Senate. Today's Clean Air Act petition, however, demonstrates that the Obama administration already pos tools to achieve deep and rapid greenhouse emissions reductions from major polluters consistent with what science demands.

The UN's top climate scientist, Rajendra Pachauri, chairman of the Intergovernmental Panel on Climate Change, endorsed redu our atmosphere to no more than 350 ppm. NASA's top climate scientist James Hansen has long advocated the need to reach 3

"The science, unfortunately, is all too clear — 350 ppm is the most CO2 we can have in the atmosphere if we want a planet 'sim which civilization developed.' Around the world people have rallied around that number, in what CNN called 'the most widesprea action in the planet's history;' 92 national governments have endorsed it as a target. Now it's time for the nation that invented en to use its most progressive set of laws in the same effort," said Bill McKibben, founder of 350.org.

While the Obama administration is moving forward to reduce greenhouse pollution from automobiles and smokestacks under th two laudable and critically important steps, the administration to date has failed to implement other important and legally require the Act.

Today's petition seeks a national pollution cap for CO2 and other greenhouse pollutants through a central provision of the Clean EPA to designate "criteria" air pollutants, set national pollution limits for these pollutants to protect the public health and welfare, the states in carrying out plans to reduce emissions from major sources to attain or maintain the national standards.

To date, EPA has designated six criteria pollutants: particle pollution (PM), ground-level ozone (O3), carbon monoxide (CO), su nitrogen oxides (NOx), and lead. The petition seeks the addition of seven greenhouse gases to the list, including CO2 with a cap 350 ppm, as well as designation and caps for methane (CH4), nitrous oxide (N2O); hydrofluorocarbons (HFCs); perfluorocarbon hexafluoride (SF6); and nitrogen trifluoride (NF3).

Setting science-based national pollution caps for these greenhouse gases would mark a critical step in the fight against global w more tools to the Clean Air Act programs the Obama administration is beginning to implement. A national pollution cap for gree

would also activate and coordinate the efforts of all 50 states, all of which currently implement plans for the reduction of the exis pollutants, and 38 of which are already drafting or implementing climate action plans.

“The Clean Air Act is a bipartisan bill signed by a Republican president. Leading scientists at NASA and around the world say w 350 ppm. This petition simply asks EPA to do its job as science, the law, and common sense require,” said McKibben.

“Rather than perpetually wait for flawed and inadequate new climate legislation before taking meaningful action, the Obama adm and must use the existing authorities under the Clean Air Act to set a target of 350 parts per million to protect the climate and ou Siegel.

The climate bill passed by the U.S. House of Representatives, as well as legislation currently pending in the Senate, would elim authority under the Clean Air Act to designate greenhouse gases as criteria air pollutants and to set a cap on such emissions as today’s petition.

Click here to read the petition.
To learn more, visit the Center’s Clean Air Act Web page.
Read frequently asked questions on establishing national pollution limits for greenhouse gases Under the Clean Air Act.

The Center for Biological Diversity is a national, nonprofit conservation organization with more than 240,000 members and dedicated to the protection of endangered species and wild places.

350.org organized the most widespread day of environmental action in the planet's history on October 24, 2009 when people at more than 5,200 events gathered to call for action on the climate crisis.

The administration expressed its goal as a 17-percent reduction from the 2005 greenhouse gas emission level. The United Nati the world express reduction goals based on 1990 levels. A 17-percent reduction from 2005 is equivalent to a 3-percent reductio

Arizona . California . Nevada . New Mexico . Alaska . Oregon . Illinois . Minnesota . Vermont . Washing
P.O. Box 710 . Tucson, AZ 85702-0710 tel: (520) 623.5252 fax: (520) 623.9797 www.Biological

CBD Petition_GHG_pollution_cap_12-2-2009.pdf

Confidential communication for internal deliberations only; Attorney-client, attorney work product and/or enforcement privilege; Do not distribute outside EPA or DOJ

Carol S. Holmes
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW (MC 2344A)
Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

BEFORE THE ADMINISTRATOR OF THE ENVIRONMENTAL PROTECTION AGENCY

PETITION TO ESTABLISH NATIONAL POLLUTION LIMITS FOR GREENHOUSE GASES PURSUANT TO THE CLEAN AIR ACT

Smokestacks by Phillip J. Redman, USGS; polar bear © Thomas D. Mangelsen/Imagesofnaturestock.com; Times Square © Shadia Fayne Wood

Center for Biological Diversity
350.org
Petitioners

December 2, 2009

EXECUTIVE SUMMARY

As atmospheric carbon dioxide levels approach 390 parts per million (ppm), the consequent effects of global warming are becoming ever more apparent. Severe droughts and heat waves, extreme weather events, and other climate disruptions are leaving more than 300,000 people dead per year. Arctic sea ice loss, bleaching of coral reefs, and species extinctions are mounting. At this moment, there can be no reasonable dispute that greenhouse gases endanger public health and welfare and that concentrations of carbon dioxide and other greenhouse gases in the atmosphere already exceed safe levels. Indeed, the Environmental Protection Agency (EPA) concluded in April 2009 that "[t]he evidence points ineluctably to the conclusion that climate change is upon us as a result of greenhouse gas emissions, that climate changes are already occurring that harm our health and welfare, and that the effects will only worsen over time in the absence of regulatory action."[1]

Through this Petition, the Center for Biological Diversity and 350.org request that the EPA do what the science dictates and the law requires: take necessary regulatory action to control greenhouse gas emissions. As a matter of both law and science, EPA must recognize that carbon dioxide and other greenhouse gases are reasonably anticipated to endanger public health and welfare. Accordingly, Petitioners request that EPA declare carbon dioxide a "criteria" air pollutant pursuant to the Clean Air Act and set a national pollution limit (National Ambient Air Quality Standard, or NAAQS) for carbon dioxide at no greater than 350 ppm—a level that accurately reflects the most recent scientific knowledge. Petitioners further request that EPA similarly designate other greenhouse gases as criteria pollutants and establish pollution caps for those gases at science-based levels.

Under the Clean Air Act, the Obama administration and the EPA have not only the authority, but also the clear legal duty, to take such action as is necessary to set the United States on a course towards reducing atmospheric carbon dioxide concentrations below dangerous levels. Designating carbon dioxide and other greenhouse gases as criteria pollutants and setting appropriate science-based national pollution limits for each such pollutant are essential components of this process.

The Clean Air Act provides the tools necessary for the U.S. to commit to the deep and rapid greenhouse emissions reductions—on the order of 45% or more below 1990 levels by 2020—needed to avert the worst impacts of climate change. National pollution caps for greenhouse gases under the Clean Air Act would provide a scientific benchmark to guide all national climate policy. These national pollution caps also would serve as the basis for development of emissions reduction trajectories to achieve those limits. Those reductions would then be implemented by the states through updates of their existing "state implementation plans." Because the existing Clean Air Act not only facilitates but requires such efforts, the Obama administration need not gamble on whether Congress will pass new climate legislation, but rather should move quickly to commit to such reductions in the international climate negotiations of the United Nations Framework Convention on Climate Change.

[1] The Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886, 19904 (April 24, 2009).

Establishing science-based national pollution caps for greenhouse gases would rely on the heart of the Clean Air Act—a set of comprehensive and complementary provisions already proven effective in controlling air pollution from most major sources in the U.S. This petition seeks action under Clean Air Act sections 108-110 (42 U.S.C. §§ 7408-7410), which govern designation of criteria air pollutants, establishment of national air pollution limits (NAAQS), and coordination of state implementation planning. Section 108 (42 U.S.C. § 7408) requires EPA to make a list of air pollutants emitted by many or diverse sources that cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. Within 12 months of adding a pollutant to the list, the EPA must issue air quality "criteria" that specify the pollutant's known effects on the public health and welfare, and "accurately reflect the latest scientific knowledge."[2] Upon issuance of these criteria, EPA also must set a national pollution limit sufficient to protect the public health and welfare, pursuant to section 109 (42 U.S.C. § 7409). Under section 110 (42 U.S.C. § 7410), each state must develop and implement a state implementation plan to meet the national pollution limit through enforceable emissions controls for pollution sources within that state. Other complementary provisions of the statute aid the states in meeting the national pollution limit through additional requirements for stationary and mobile pollution sources.

The Clean Air Act's state implementation program is a vital component of a comprehensive and cost-effective strategy to significantly reduce greenhouse gases. State implementation plans describe how each state will implement, maintain, and enforce existing national pollutant limits in a manner that allows each state to take its own emissions profile and industry needs into account. States have long-standing experience in reducing existing criteria pollutants through the state implementation plan process.

Indeed, through independent processes, many states already have taken several of the steps necessary for greenhouse gas-related state implementation planning. As of August 2009, at least forty-seven states have completed or are completing a greenhouse gas inventory, thirty-eight are drafting or have drafted climate action plans, and twenty-three states have adopted emissions reduction targets.[3] Many of these programs achieve progress in areas not typically covered under federal programs, including land use regulation, local building codes, density patterns of development and transportation infrastructure, and the regulation of agriculture, forestry and non-hazardous waste handling, activities which together account for a significant share of total U.S. greenhouse gas emissions. The state implementation planning process will leverage such state emission control efforts by adding a common, science-based greenhouse gas pollution limit, providing technical information and assistance, ensuring consistency among states, and addressing interstate leakage concerns by requiring the participation of those states that have yet to take action—all while retaining maximum local implementation flexibility. State implementation plans will serve to integrate rapidly expanding state and local climate change programs into a comprehensive and efficient national effort.

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[2] Clean Air Act § 108, 42 U.S.C. § 7408(a)(2). The criteria pollutants listed to date are particle pollution (PM), ground-level ozone (O_3), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead.

[3] U.S. Envtl. Prot. Agency, State and Local Governments, State Planning and Measurement, http://www.epa.gov/climatechange/wycd/stateandlocalgov/state_planning html#three (last visited Dec. 1, 2009); Pew Ctr. on Global Climate Change, U.S. Climate Policy Maps, http://www.pewclimate.org/what_s_being_done/in_the_states/state_action_maps.cfm (last visited Dec. 1, 2009).

Moreover, a national pollution limit for greenhouse gases will effectively guide both the Clean Air Act's other pollution reduction programs and other complementary efforts that may be initiated through new legislation. Informed by a science-based national pollution limit, the Clean Air Act's other successful pollution reduction programs, such as new source review, new source performance standards, and greenhouse gas reduction rules for automobiles and other mobile pollution sources, will provide the essential blueprint for the United States' greenhouse gas reduction efforts.

Climate change obviously poses global problems. Yet these problems cannot be solved unless each nation limits its own emissions sufficiently to achieve its share of the reductions necessary to stabilize atmospheric greenhouse gas concentrations below dangerous levels. With the Clean Air Act, the Obama administration and the EPA already have in their grasp a set of uniquely effective tools to reach this goal: existing and robust legal authority to set national pollution limits for greenhouse gases and to facilitate preparation of state implementation plans that will move toward attainment of those limits.

For these reasons, Petitioners Center for Biological Diversity and 350.org, pursuant to the Clean Air Act, 42 U.S.C. §§ 7401 et seq., its implementing regulations, and the Administrative Procedures Act, 5 U.S.C. § 553(e), hereby request that the Administrator of the Environmental Protection Agency (hereinafter "Administrator," or "EPA") regulate the following long-lived greenhouse gases pursuant to Clean Air Act Sections 108-110 (42 U.S.C. §§ 7408-7410):

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs)[4];
- Perfluorocarbons (PFCs);
- Sulfur hexafluoride (SF_6); and
- Nitrogen trifluoride (NF_3).

Specifically, Petitioners request that the EPA complete the following actions:

(1) Pursuant to Clean Air Act section 108(a)(1) (42 U.S.C. § 7408(a)(1)): promptly revise the list of pollutants which may reasonably be anticipated to endanger public heath or welfare to include the greenhouse gases;

(2) Pursuant to Clean Air Act section 108(a)(2) (42 U.S.C. § 7408(a)(2)): expeditiously (but in no event later than 12 months from the revision of section 108(a)(1) list) issue air quality criteria for the greenhouse gases;

(3) Pursuant to Clean Air Act section 109(a) (42 U.S.C. § 7409(a)): publish, simultaneously with the air quality criteria described above, proposed national primary and

[4] Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. Appendix A provides a complete list of the petitioned HFCs and PFCs.

secondary pollution caps (national ambient air quality standards, or NAAQS) for the greenhouse gases in order to protect the public health and welfare, and finalize the pollution caps no later than 90 days from the initial publication;

(4) Pursuant to Clean Air Act sections 108 & 108(f) (42 U.S.C. §§ 7408 & 7408(f)): expeditiously make available information on processes, procedures, and methods to reduce or control pollutants of the greenhouse gases in transportation, from other mobile sources, and to protect the health of sensitive individuals and groups pursuant to section 108(f), and carry out all of the other related actions specified in section 108;

(5) Pursuant to Clean Air Act section 108(b)(1) (42 U.S.C. § 7408(b)(1)): simultaneously with the issuance of the air quality criteria above, issue information on air pollution control techniques for the greenhouse gases;

(6) Pursuant to Clean Air Act section 110 (42 U.S.C. § 7410): expeditiously facilitate and aid the states in the state implementation plan process.

In short, the Clean Air Act already contains the comprehensive, science-based, flexible, and immediately available tools necessary to address the climate crisis. For four decades, the Clean Air Act has vastly improved air quality and reduced pollution levels, saved lives and provided health and economic benefits worth many times the cost of the pollution reductions. The Clean Air Act is one of the most efficient and successful environmental laws ever devised, and its science and technology-based mechanisms are time-tested and well understood by both industry and state and federal agencies throughout the nation. This comprehensive, yet flexible and cooperative, pollution reduction system is well-suited to combat the greatest environmental crisis the modern world has faced—global warming caused by greenhouse gas emissions. The Obama administration can and must begin using its authority under the Clean Air Act towards this end.

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NOTICE OF PETITION

I. Statutory Authority and Actions Requested

Pursuant to the Clean Air Act, 42 U.S.C. §§ 7401 et seq., its implementing regulations, and the Administrative Procedures Act, 5 U.S.C. § 553(e), Petitioners Center for Biological Diversity and 350.org hereby request that the Administrator of the Environmental Protection Agency take the actions described herein with respect to the following long-lived greenhouse gases:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Hydrofluorocarbons (HFCs)[5];
- Perfluorocarbons (PFCs);
- Sulfur hexafluoride (SF_6); and
- Nitrogen trifluoride (NF_3).

The specific actions requested with regard to the five greenhouse gases and two categories of greenhouse gases which are the subject of this petition are as follows:

(1) Pursuant to Clean Air Act section 108(a)(1) (42 U.S.C. § 7408(a)(1)): promptly revise the list of pollutants which may reasonably be anticipated to endanger public health or welfare to include the greenhouse gases;

(2) Pursuant to Clean Air Act section 108(a)(2) (42 U.S.C. § 7408(a)(2)): expeditiously (but in no event later than 12 months from the revision of section 108(a)(1) list) issue air quality criteria for the greenhouse gases;

(3) Pursuant to Clean Air Act section 109(a) (42 U.S.C. § 7409(a)): publish, simultaneously with the air quality criteria described above, proposed national pollution caps (national primary and secondary ambient air quality standards) for the greenhouse gases in order to protect the public health and welfare, and issue final pollution caps no later than 90 days from the initial publication;

(4) Pursuant to Clean Air Act sections 108 & 108(f) (42 U.S.C. §§ 7408 & 7408(f)): expeditiously make available information on processes, procedures, and methods to reduce or control pollutants of the greenhouse gases in transportation, from other mobile sources, and to protect the health of sensitive individuals and groups pursuant to section 108(f), and carry out all of the other related actions specified in section 108;

[5] Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. Appendix A provides a complete list of the petitioned HFCs and PFCs.

(5) Pursuant to Clean Air Act section 108(b)(1) (42 U.S.C. § 7408(b)(1)): simultaneously with the issuance of the air quality criteria described above, issue information on air pollution control techniques for the greenhouse gases;

(6) Pursuant to Clean Air Act section 110 (42 U.S.C. § 7410): expeditiously facilitate and aid the states in the State Implementation Plan process.

Pursuant to the Administrative Procedure Act, 5 U.S.C. § 553(e), and the Clean Air Act, 42 U.S.C. §§ 7401 et seq., petitioners file this petition and respectfully request that EPA undertake these mandatory duties. This petition places definite response requirements on the EPA. The scientific basis for the requested actions is set forth fully in the petition and the literature cited herein.

II. Petitioners

The Center for Biological Diversity works through science, law, and creative media to secure a future for all species, great or small, hovering on the brink of extinction. The Center's Climate Law Institute develops and implements legal campaigns to limit global warming pollution and prevent it from driving species extinct. The Center has over 225,000 members and online activists with a vital interest in the immediate reduction of greenhouse gas pollution under the Clean Air Act as one of the primary solutions to the climate crisis. www.biologicaldiversity.org

350.org is an international campaign dedicated to building a movement to unite the world around solutions to the climate crisis--the solutions that science and justice demand. Their focus is on the number 350--as in parts per million, the level scientists have identified as the safe upper limit for CO2 in our atmosphere. On October 24, 2009, 350.org organized the most widespread day of environmental action in the planet's history, when people in 181 countries at over 5,200 events gathered to call for action on the climate crisis. www.350.org

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INTRODUCTION AND OVERVIEW OF THE CLEAN AIR ACT

I. The Clean Air Act: Background and Structure

The Clean Air Act is one of the nation's and the world's most important and successful environmental laws. Enacted in 1970 in response to growing environmental awareness, the Clean Air Act uses a variety of complementary pollution control mechanisms, as well as combined federal-state action termed "cooperative federalism,"[6] to reduce pollution from all sectors of the U.S. economy. The Act's far-reaching and effective pollution reduction mechanisms have substantially improved air quality and public health over the past four decades even though the American economy has expanded dramatically at the same time.

The Clean Air Act today consists of six titles which provide comprehensive, and in many cases overlapping and complementary, provisions to control pollution from most major sources in the U.S. Title I of the Clean Air Act addresses air pollution from stationary sources.[7] The program established by sections 108-110 (42 U.S.C. §§ 7408-7410) dealing with criteria air pollutants, national air pollution limits (national ambient air quality standards, or NAAQS), and state implementation planning is in many ways the heart of the modern law. Section 108 (42 U.S.C. § 7408) requires EPA to list air pollutants emitted by many or diverse sources that cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. Within 12 months of adding a pollutant to the list, the EPA must issue air quality criteria which specify the known effects on the public health and welfare from each such pollutant. The criteria pollutants listed to date are particle pollution (PM), ground-level ozone (O_3), carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead. For each criteria pollutant, EPA must set a national pollution limit as necessary to protect the public health and welfare, pursuant to Section 109 (42 U.S.C. § 7409). Under section 110 (42 U.S.C. § 7410), each state must develop and implement a state implementation plan to meet the national pollution limit through enforceable emissions controls for pollution sources within that state. Other complementary provisions of the statute aid the states in meeting the national pollution limit through additional requirements for stationary and mobile pollution sources.

Under section 111 (42 U.S.C. § 7411), EPA must set new source performance standards for major categories of new and modified stationary pollution sources. EPA sets new source performance standards for both criteria and non-criteria pollutants. While the new source review program (discussed below) relies upon site-specific and individual permit review, the new source performance standards set a threshold level for emissions which a prevention of significant deterioration permit must meet or exceed. Once a new source performance standard has been established for a new and/or modified source, the states must set standards for existing sources in each category, except for criteria pollutants and hazardous air pollutants regulated pursuant to section 112 (42 U.S.C. § 7412).

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[6] *See, e.g.*, Holly Doremus & W. Michael Hanemann, *Of Babies and Bathwater, Why the Clean Air Act's Cooperative Federalism Framework Is Useful for Addressing Global Warming*, 50 ARIZ. L. REV. 799, 827-28 (2008).

[7] *See generally* DAVID R. WOOLEY & ELIZABETH M. MORSS, THE CLEAN AIR ACT HANDBOOK (Thompson West ed., 8th ed. 2008) (for further background on the Clean Air Act).

Section 112 (42 U.S.C. § 7412) requires EPA to list and issue national emissions standards for hazardous air pollutants (HAPs) from stationary sources. The Act contains low thresholds for these air toxics, defined as any pollutant that presents or may present a threat of adverse human or environmental effects, including carcinogenic, mutagenic, neurotoxic and acutely or chronically toxic substances.

The new source review program provides controls for new major sources or modifications of major sources of pollution in order to meet the national pollution caps, and is made up of two sub-programs, prevention of significant deterioration and non-attainment new source review. The prevention of significant deterioration program is designed to prevent new and modified sources from degrading air quality in areas where the air is clean enough to fall within the national pollution limits, known as "attainment areas." This program, found in Clean Air Act sections 7470-7492, requires all new and modified stationary sources to undergo a preconstruction permitting process and to install best available control technology for each pollutant otherwise subject to regulation under the Act. The second new source review sub-program, known as "non attainment new source review," provides similar but more ambitious permitting requirements for sources in areas where the national pollution limits are not being met, termed "non-attainment areas."

Title II of the Clean Air Act requires EPA to regulate mobile sources of air pollution, including passenger vehicles pursuant to section 202 (42 U.S.C. § 7521), ships and non-road vehicles pursuant to section 213 (42 U.S.C. § 7547), and aircraft pursuant to section 231 (42 U.S.C. § 7571). Title II also provides for the regulation of the fuels used to power these mobile sources, and section 211(o) (42 U.S.C. § 7545(o)) establishes the renewable fuels standard program, which requires an increase in the use of renewable fuels with significantly lower lifecycle greenhouse gas emissions than the fossil-fuel based fuels they replace.

Titles III provides general provisions related to reporting on the effectiveness of the act, air quality monitoring, citizen suits, and other matters.

Title IV, established by the 1990 Amendments, added a trading program to control SO_2, a primary acid rain precursor. Under the Title IV program, regulated utilities must hold pollution allowances equal to their total allowed emissions of SO_2, and may meet their reduction obligations either by reducing pollution at their own facility or by buying allowances from other facilities that reduced their pollution below the allowed levels.

Title V, also added by the 1990 Amendments, enhanced the ability of state and federal regulators and citizen groups to monitor compliance with the Act by establishing a new operating permit system. The Title V permitting system requires all new and existing major sources to have an operating permit listing all of the rules and regulations applicable to the facility, and requires permittees to monitor compliance, self-report any violations at least semi-annually, and certify compliance annually.

Title VI requires EPA to take a number of actions to protect the stratosphere, including especially the ozone layer which protects the Earth from harmful UVB radiation. Section 615

(42 U.S.C. § 7671n) provides broad authority to regulate ozone-depleting substances that endanger public health and welfare.

II. Benefits from Past Regulation Under the Clean Air Act Vastly Outweigh the Costs

The Clean Air Act has provided indispensible benefits to this country for more than four decades. Study after study has shown that the substantial improvements in air quality achieved through the Act have not only resulted in enormous public health, ecological, and other benefits, but have also been accomplished so efficiently that the economic value of the benefits exceed by many times the costs of the pollution reduction measures.

Under the 1990 Clean Air Act amendments, Congress required EPA to issue a comprehensive assessment of the Clean Air Act's impact on the "public health, economy, and environment of the United States."[8] EPA issued the first such report in October 1997, following an extensive and rigorous research and modeling effort.[9] It found that emissions of SO_2 were 60 percent lower from industrial processes and 40 percent lower from electricity generation, emissions of VOCs 66 percent lower, emissions of NO_x 47 percent lower, emissions of CO 56 percent lower, emissions of PM from electric utilities 93 percent lower, and emissions of PM from industrial processes 76 percent lower in 1990 than they would have been without the Clean Air Act.[10] Emissions of airborne lead had been virtually eliminated.[11] EPA modeled the impact of the resulting improvements in air quality on human health, including impacts such as respiratory symptoms, hospital admissions, asthma attacks, and chronic sinusitis from exposure to ozone; mortality, bronchitis, hospital admissions, and lost work days from exposure to PM; hospital admissions for congestive heart failure from exposure to CO; respiratory illness from exposure to NO_x; changes in pulmonary function and respiratory symptoms from exposure to SO_2; and mortality, hypertension, coronary heat disease, strokes, and IQ loss from exposure to lead.[12] EPA also modeled selected welfare effects including changes in crop yields from exposure to ozone, household soiling from PM, and visibility impairment from PM, NO_x and SO_2.[13]

[8] Clean Air Act § 312, 42 U.S.C. § 7612 (2008) (the review requirements are often referred to as the "section 812" requirements as they were included in section 812 of the 1990 Clean Air Act amendments).
[9] U.S. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT: 1970 TO 1990 (1997), *available at* http://www.epa.gov/air/sect812/copy.html. EPA conducted the study in consultation with an outside panel of highly qualified experts known as the Advisory Council on Clean Air Act Compliance Analysis organized in 1991 under the auspices of EPA's Science Advisory Board. The study constructed and compared a "no-control scenario," in which federal, state, and local air pollution controls are frozen at the levels of stringency and effectiveness that existed in 1970 to a "control scenario" which assumes that all federal, state, and local rules promulgated pursuant to the Clean Air Act during 1970 to 1990 were implemented. The analysis estimates the differences between the economic and environmental outcomes associated with these two scenarios and brings a level of validity, breadth, and integration that exceeded any effort to that time.
[10] *Id.* at 15-17.
[11] *Id.*
[12] *Id.* at 31.
[13] *Id.* at 32.

EPA concluded that the economic benefits of Clean Air Act implementation, valued in 1990 dollars, range from $5.6 to $49.4 trillion with a central estimate of $22.2 trillion.[14]

EPA also analyzed the cost of the pollution reductions by examining changes in patterns of industrial production, capital investment, productivity, consumption, employment, and overall economic growth. Using a 5% discount rate, EPA estimated the total costs of the Clean Air Act regulations to be $.523 trillion.[15]

The economic value of the Act's benefits, therefore, was about 42 times greater than its costs.

More recent analyses have continued to affirm both the effectiveness and efficiency of the Clean Air Act. In 1999 EPA released the first prospective cost-benefit analysis of the 1990 Clean Air Act amendments, and concluded once again that the value of the benefits from the amendments would far exceed the costs. In total EPA estimated that in 2010 the benefits due to the 1990 Amendments would prevent 23,000 Americans from dying prematurely, avert over 1,700,000 incidences of asthma attacks and aggravation of chronic asthma, prevent 67,000 incidences of chronic and acute bronchitis, 91,000 occurrences of shortness of breath, 4,100,000 lost work days, and 31,000,000 days in which Americans would have had to restrict activity due to air pollution related illness, in addition to preventing 22,000 respiratory-related hospital admissions, 42,000 cardiovascular hospital admissions, and 4,800 emergency room visits for asthma.[16] The total value of the health and ecological benefits totaled $110 billion, as opposed to only about $27 billion in costs.[17]

Thus, early critics who claimed that the Act would be unworkable, too expensive and an unsustainable burden on the American economy have been proven incorrect. "[W]hile industry claims often frame the debate, they are usually exaggerated, not accurate descriptions of the truth but tactics to stop unwanted measures, regardless of the need or merit. Many business interests predicted catastrophe were the [Clean Air Act] enacted. DuPont Chemical warned of 'severe

[14] *Id.* at ES-8. EPA stressed that the monetary quantification method tended to underestimate health and environmental benefits for a number of reasons. First, limitations in air quality modeling prevented comprehensive estimates in changes in air quality. *Id.* at 25-27. Second, a wide variety of beneficial impacts to both health and the environment could not be quantified economically. *Id.* at 30. Third, the valuation of many health effects included economic costs such as physician visits, medications costs, and lost work time, but excluded the value of what one would be willing to pay to avoid the associated pain and suffering and thus, the valuations almost certainly represent lower-bound estimates for these impacts. Moreover, many recent studies show that exposure to air pollution, particularly ozone and particulate matter, is actually far more dangerous and deadly than previously thought, again tending to show that the major EPA reports of the past decade almost certainly have *underestimated* the Act's benefits.

[15] *Id.* at ES-8.

[16] U.S. ENVTL. PROT. AGENCY, THE BENEFITS AND COSTS OF THE CLEAN AIR ACT: 1990 TO 2010 60-61 (1999), *available at* http://www.epa.gov/air/sect812/1990-2010/fullrept.pdf; *see also* Press Release, U.S. Envtl. Prot. Agency, The Benefits and Costs of the Clean Air Act, First Protective Study (Nov. 16, 1999), http://www.epa.gov/air/sect812/r-140 html (last visited Dec. 1, 2009).

[17] U.S. ENVTL. PROT. AGENCY, *supra* note 16, at iii-iv.

economic and social disruption,' and Mobil 'severe supply chain disruptions' for gasoline. But no one rioted, the economy grew, and Americans never had a problem filling up their tanks."[18]

III. The Clean Air Act Is a Highly Cost-Effective Tool to Regulate Greenhouse Gases from All Major Sources in the U.S.

Despite these lessons of the past, naysayers continue to claim that regulation of greenhouse gases under the Clean Air Act is unworkable or inappropriate. They argue that the Clean Air Act is "broken," unsuitable to the regulation of greenhouse gases, or that regulation will be too expensive.[19] These arguments, however, are unsupported and contradicted by EPA's data and analysis, and are no more correct today than they were when the Clean Air Act was first enacted.

Initially, it should be noted that most of the industries that will be affected by greenhouse gas controls are already regulated under the Clean Air Act to control other pollutants they emit; as a result, the application of the same general procedures to limit emissions of another set of pollutants will result in fewer additional costs.[20] Moreover, regardless of start-up or ongoing regulatory costs, a robust economics literature demonstrates that greenhouse pollution reduction will have a net economic benefit. The Stern Review of the Economics of Climate Change, a comprehensive report commissioned by the British government, concluded that allowing current greenhouse gas emissions trajectories to continue unabated would cost the global economy between 5 to 20 percent of Gross Domestic Product (GDP) each year within a decade, or up to $7 trillion per year, and warned that these figures should be considered conservative estimates.[21] By contrast, measures to mitigate global warming by reducing emissions were estimated to cost about one percent of global GDP each year, and could save the world up to $2.5 trillion per

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[18] HENRY WAXMAN WITH JOSHUA GREEN, THE WAXMAN REPORT: HOW CONGRESS REALLY WORKS 101-102 (Twelve/Grand Central Publishing 2009).

[19] *See, e.g.*, Advance Notice of Proposed Rulemaking Regulating Greenhouse Gas Emissions Under the Clean Air Act, Proposed Rule, 73 Fed. Reg. 44354, 44356 (July 30, 2008).

[20] As EPA also noted, "[t]he electricity generation, transportation and industrial sectors, the three largest contributors to GHG emission in the U.S., are subject to Clean Air Act controls to help meet national ambient air quality standards, control acid rain, and reduce exposures to toxic emissions." *Id.* at 44407. For example, coal-fired power plants must already comply with emissions limits applicable to nitrous oxides, sulfur dioxides and other pollutants, and they must purchase and maintain equipment to monitor their emissions. *See, e.g.*, Standards of Performance for Electric Utility Steam Generating Units, 74 Fed. Reg. 5072 (Jan. 28, 2009) (to be codified at 40 C.F.R. Part 60). Similarly, dry cleaning plants, sometimes invoked as an example of an industry that could not financially withstand greenhouse emission controls, have long been regulated to reduce pollutants they create but have found innovative ways to perform their services while reducing that pollution. *See, e.g.*, Standards of Performance for New Stationary Sources; Perchloroethylene Dry Cleaners, 45 Fed. Reg. 78174 (Nov. 25, 1980) (to be codified at 40 CFR Part 60). In any event, sources emitting less than 25,000 tons of CO_2eq per year will not initially be required to obtain prevention of significant deterioration, non-attainment or Title V permits under EPA's proposed Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 74 Fed. Reg. 55292 (Oct. 27, 2009) (to be codified at 40 CFR Parts 51, 52, 70, and 71) (hereinafter referred to as "the Tailoring Rule"). A national pollution cap for greenhouse gases will invoke the same basic mechanisms for pollution reduction. The application of already existing and well-understood Clean Air Act pollution control processes to another set of pollutants – greenhouse gases – will thus involve fewer start-up costs and create fewer inefficiencies than those experienced during the initial implementation of the Clean Air Act, or those that would attend the implementation of a different, unproven set of regulations.

[21] SIR NICHOLAS STERN, STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE (Cambridge University Press 2006), *available at* http://www.sternreview.org.uk.

year.[22] If no action to control emissions is taken, each ton of carbon dioxide emitted today is causing societal damage worth at least $85.[23] Thus economic analysis demonstrates convincingly that nothing could be more costly than continued "business-as-usual" greenhouse gas emissions, while greenhouse gas pollution reduction measures will produce vast economic benefits.

A recent survey of leading economists confirmed the weight of the economic argument for action: 84% of respondents agreed or strongly agreed that "the environmental effects of greenhouse gas emissions, as described by leading scientific experts, create significant risks to important sectors of the United States and global economies." Seventy-five percent agreed or strongly agreed that "uncertainty associated with the environmental and economic effects of greenhouse gas emissions increases the value of emission controls, assuming some level of risk-aversion." And 57% believed that the U.S. government should commit to greenhouse gas reductions "regardless of the actions of other countries."[24]

Thus, despite the fact that cost benefit analysis tends to understate the true benefits of protecting the air we breathe, the water we drink, and the food we eat[25], even this method demonstrates the cost effectiveness of greenhouse pollution reduction measures.

The actions requested in this petition are consistent with and additive to EPA's multiple existing obligations to regulate greenhouse gases under the Clean Air Act pursuant to other rulemakings and proceedings. These obligations include, but are not limited to the following:

- The obligation to immediately finalize the proposed Endangerment Finding and begin regulating greenhouse gas emissions from motor vehicles pursuant to Clean Air Act Section 202.

- The obligation to immediately issue an endangerment finding and begin regulating GHG emissions from ships and off-road engines pursuant to Clean Air Act section 213.

- The obligation to immediately issue an endangerment finding and begin regulating greenhouse gas emissions from aircraft pursuant to Clean Air Act section 231.

- The obligation to update existing New Source Pollution Standards, and issue new standards, as necessary to include limits and reduction measures for greenhouse gases pursuant to Clean Air Act section 111.

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[22] *Id.*
[23] *Id.*
[24] J.SCOTT HOLLADAY ET AL., NEW YORK UNIV. SCH. OF LAW INST. FOR POLICY INTEGRITY, ECONOMISTS AND CLIMATE CHANGE, CONSENSUS AND OPEN QUESTIONS (2009), *available at* http://www.policyintegrity.org/publications/index html.
[25] *See, e.g.*, RENA STEINZOR ET AL., CTR. FOR PROGRESSIVE REFORM, A RETURN TO COMMON SENSE: PROTECTING HEALTH, SAFETY, AND THE ENVIRONMENT THROUGH "PRAGMATIC REGULATORY IMPACT ANALYSIS" (2009), *available at* http://www.progressivereform.org/whitePapers.cfm.

- The obligation to immediately begin regulating greenhouse gases pursuant to the New Source Review program.

ARGUMENT IN SUPPORT OF PETITIONED ACTIONS

I. EPA Must Issue an Endangerment Finding for Greenhouse Gas Emissions Pursuant to Section 108

The program established by sections 108-110 (42 U.S.C. §§ 7408-410) is designed to work in a complementary and additive manner with many of the Act's other provisions. Section 108 (42 U.S.C. § 4708) requires EPA to list air pollutants that are emitted by many sources and that cause or contribute to air pollution problems. Within 12 months of adding a pollutant to the list, EPA must issue air quality criteria which specify all of its known effects on the public health and welfare. EPA is then required to set national pollution caps (national ambient air quality standards, or NAAQS) for each such "criteria pollutant" as necessary to protect the public health and welfare, pursuant to section 109 (42 U.S.C. § 4709). Under section 110 (42 U.S.C. § 4710), each state must develop and implement a state implementation plan to meet the national pollution cap through enforceable emissions controls for pollution sources within the state. Other complementary provisions aid the states in meeting the national pollution cap through additional requirements for stationary and mobile pollution sources.

This national pollutant cap program is among the most successful programs established by the Clean Air Act and has a proven record of accomplishment in effectively dealing with complex air pollution problems that implicate a multitude of sources and a wide range of economic activities. Through their previous experience with the state implementation plans for other criteria pollutants, states have significant expertise with the national pollution caps and have effectively utilized state implementation plans to regulate those pollutants. The substantial knowledge, experience and capacity that currently exist can and must be put to use to address greenhouse gases.

A. The Section 108 Endangerment Finding

Section 108(a)(1) (42 U.S.C. § 4708(a)(1)) establishes the threshold test for listing criteria air pollutants:

> (1) For the purpose of establishing national primary and secondary ambient air quality standards [national pollution caps] the Administrator shall within 30 days after December 31, 1970, publish, and shall from time to time thereafter revise, a list which includes each air pollutant –
>
> > (A) emissions of which, in his judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare;

> (B) the presence of which in the ambient air results from numerous or diverse mobile or stationary sources; and
>
> (C) for which air quality criteria had not been issued before December 31, 1970, but for which he plans to issue air quality criteria under this section.

The finding under section 108(a)(1)(A) (42 U.S.C. § 4708(a)(1)(A)) is known as the "endangerment finding." In its proposed Endangerment Finding for greenhouse gas emissions from automobiles under section 2002, EPA has already concluded that greenhouse gas emissions endanger public health and welfare. And as discussed in section I.D., below, because the test's subparts (B) and (C) have also been met, the EPA must promptly designate the greenhouse gases as criteria air pollutants as requested herein.

B. Data Sources and Climate Scenarios

EPA currently has more than sufficient information and analysis to issue the endangerment finding required by section 108 (42 U.S.C. § 4708). Much of this information is discussed in the proposed Endangerment Finding and the supporting documents in Docket OAR-2009-0171, the Advance Notice of Proposed Rulemaking and Docket OAR-2008-0318, and the Supreme Court's decision in *Massachusetts v. EPA*. This combined record contains more than enough evidence of the threat greenhouse gases pose to public health and welfare, and indeed compels EPA to make the Section 108 endangerment finding petitioned here immediately.

Authoritative synthesis reports and data sources which should form the foundation of the Section 108 endangerment finding include but are not limited to the following:

- The Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886 (April 24, 2009) (hereinafter proposed Endangerment Finding);

- The Technical Support Document for the Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act (April 17, 2009), Docket No. OAR-2009-0171;

- The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change ("IPCC AR4");[26]

[26] The IPCC was established by the World Meteorological Organization and the United Nations Environment Programme in 1988 to assess available scientific and socio-economic information on climate change and its impacts and the options for mitigating climate change and to provide, on request, scientific and technical advice to the Conference of the Parties to the United Nations Framework Convention on Climate Change. Since 1990, the IPCC has produced a series of reports, papers, methodologies, and other products that have become the standard works of reference on climate change. The *Fourth Assessment Report* (AR4), cited as supporting evidence in the proposed Endangerment Finding, is the most current comprehensive IPCC reference and has built and expanded upon the IPCC's past products. Thousands of the world's top scientists and hundreds of coordinating lead authors contributed to the AR4, which also underwent a painstaking review process in which every comment received was addressed. Each Summary for Policymakers in IPCC documents, including the AR4, is approved line-by-line, and the

- An updated report prepared by the Climate Change Research Centre at the University of New South Wales, synthesizing peer-reviewed scientific articles published since the release of IPCC AR4;[27]

- The Synthesis and Assessment Products of the U.S. Global Change Research Program (formerly the Climate Change Science Program);[28]

- National Research Council ("NRC") reports under the U.S. National Academy of Sciences ("NAS");[29]

- The Arctic Climate Impact Assessment ("ACIA");[30]

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underlying chapters are then accepted, by government delegations in formal plenary sessions. The AR4 represents an extraordinary and unprecedented level of scientific effort and coordination, but is also therefore a highly conservative consensus document. Further information about the IPCC process and reports is available at http://www.ipcc.ch/about/procd.htm.

[27] I. ALLISON ET AL., THE COPENHAGEN DIAGNOSIS 2009: UPDATING THE WORLD ON THE LATEST CLIMATE SCIENCE (2009), *available at* http://copenhagendiagnosis.org/.

[28] Pursuant to the requirements of the Global Change Research Act of 1990, 15 U.S.C. §§ 2921-2961 ("GCRA"), the Global Change Research Program (GCRP) is charged with preparing a scientific assessment of climate change impacts in the United States which must be used by all federal agencies in decisions which implicate greenhouse gas emissions and global warming. The GCRP released the most recent scientific assessment on May 29, 2008 (*Scientific Assessment of the Effects of Global Change on the United States*). The GCRP has also identified 21 synthesis and assessment products (SAPs) that address what it has identified as the highest priorities for U.S. climate change research, observation and decision-support needs; EPA is the designated lead for three of the six SAPs addressing impacts and adaptation. The EPA utilized those SAPs that were available at the time the endangerment TSD was drafted. In each Clean Air Act endangerment finding, the EPA must utilize the most recent GCRP synthesis documents, which are available at http://www.globalchange.gov/. The EPA did so in the proposed Endangerment Finding, 74 Fed. Reg. 18894. The GCRP, recently released an updated report on climate impacts in the United States that integrates existing SAPs with new peer-reviewed science. *See* U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES (2009), *available at* www.globalchange.gov/usimpacts.

[29] As the EPA has noted, "[t]he National Research Council (NRC) is part of the National Academies, which also comprise the National Academy of Sciences, National Academy of Engineering and Institute of Medicine. They are private, nonprofit institutions that provide science, technology and health policy advice under a congressional charter. The NRC has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public and the scientific and engineering communities. Federal agencies are the primary financial sponsors of the Academies' work. The Academies provide independent advice; the external sponsors have no control over the conduct of a study once the statement of task and budget are finalized. The NRC 2001 study, *Climate Change Science: An Analysis of Some Key Questions*, originated from a White House request. The NRC 2001 study, *Global Air Quality: An Imperative for Long-Term Observational Strategies*, was supported by EPA and NASA. The NRC 2004 study, *Air Quality Management in the United States*, was supported by EPA. The NRC 2005 study, *Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties*, was in response to a CCSP request, and supported by NOAA. The NRC 2006 study, *Surface Temperature Reconstructions for the Last 2,000 Years*, was requested by the Science Committee of the U.S. House of Representatives. Each NRC report is authored by its own committee of experts, reviewed by outside experts, and approved by the Governing Board of the NRC." Endangerment Technical Support Document at 3.

[30] The Arctic Council is a high-level intergovernmental forum that addresses the common concerns and challenges faced by the Arctic people and governments of the eight Arctic nations – Canada, Denmark/Greenland/Faroe Islands, Finland, Iceland, Norway, Russia, Sweden, and the United States, as well as six Indigenous Peoples organizations – Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit

- The Global Humanitarian Forum's Human Impact Report Climate Change;[31]

- Climate Change Futures: Health, Ecological, and Economic dimensions, a report of the Center for Health and the Global Environment, Harvard Medical School;[32]

- EPA annual report on U.S. greenhouse gas emission inventories.

The proposed Endangerment Finding lists some of the overwhelming evidence supporting a finding of endangerment. Because the proposed Endangerment Finding conclusions compel the same action under Section 108(a) (42 U.S.C. § 4708(a)), they are summarized in Section C below. The following discussion of basic climate change concepts and scenarios is included to clarify the context of the proposed endangerment finding.

C. EPA Must Find Under Section 108(a) that Greenhouse Gas Emissions Cause or Contribute to Air Pollution Which Endangers Public Health and Welfare, As EPA Has Already Determined Under Section 202(a)

Under Section 108(a) (42 U.S.C. § 4708(a)), EPA must set a national pollution cap for greenhouse gases if it finds that greenhouse gases are air pollutants which cause or contribute to air pollution which may "reasonably be anticipated to endanger public health or welfare." The Clean Air Act defines "welfare" as referring to effects including, but not limited to, "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being."[33] While the Clean Air Act does not include a definition of public health, the Supreme Court has defined that term in its most natural meaning: "the health of the public."[34] In considering public health, "EPA has looked at morbidity, such as impairment of lung function, aggravation of respiratory and cardiovascular disease, and other acute and chronic health effects, as well as mortality."[35] Using these

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Circumpolar Conference, Russian Association of Indigenous Peoples of the North, and Saami Council, as well as official observers. The Arctic Council commissioned the ACIA project and charged its working groups – Arctic Monitoring and Assessment Programme ("AMAP"), Conservation of Arctic Flora and Fauna ("CAFF"), and the International Arctic Science Committee ("IASC") - with its implementation. The efforts of hundreds of scientists over four years, as well as the special knowledge of indigenous peoples, contributed to the ACIA report. The ACIA (2005) is a comprehensively researched, fully referenced, and independently reviewed evaluation of Arctic climate change and its impacts.

[31] GLOBAL HUMANITARIAN FORUM, HUMAN IMPACT REPORT, CLIMATE CHANGE: THE ANATOMY OF A SILENT CRISIS (2009), *available at* http://ghfgeneva.org/Portals/0/pdfs/human_impact_report.pdf (documenting the impact of climate change on human life globally).

[32] HARVARD MED. SCHOOL CTR. FOR HEALTH AND THE GLOBAL ENV'T, CLIMATE CHANGE FUTURES HEALTH, ECOLOGICAL, AND ECONOMIC DIMENSIONS (2005), *available at* http://www.climatechangefutures.org/pdf/CCF_Report_Final_10.27.pdf.

[33] Clean Air Act § 302, 42 U.S.C. § 7602(h) (2008).

[34] *Whitman v. American Trucking Ass'n*, 531 U.S. 457, 466 (2001).

[35] Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886, 18894 (April 24, 2009) (to be codified in 40 C.F.R. Chapter 1).

definitions, the EPA's proposed Endangerment Finding found irrefutable evidence demonstrating that greenhouse gases endanger public health and welfare.

As stated in the proposed Endangerment Finding,

> *The Administrator concludes that, in the circumstances presented here, the case for finding that greenhouse gases in the atmosphere endanger public health and welfare is compelling and, indeed, overwhelming*. The scientific evidence described here is the product of decades of research by thousands of scientists from the U.S. and around the world. *The evidence points ineluctably to the conclusion that climate change is upon us as a result of greenhouse gas emissions, that climate changes are already occurring that harm our health and welfare, and that the effects will only worsen over time in the absence of regulatory action*. The effects of climate change on public health include sickness and death. It is hard to imagine any understanding of public health that would exclude these consequences. The effects on welfare embrace every category of effect described in the Clean Air Act's definition of "welfare" and, more broadly, virtually every facet of the living world around us. And, according to the scientific evidence relied upon in making this finding, the probability of the consequences is shown to range from the likely to virtually certain to occur. This is not a close case in which the magnitude of the harm is small and the probability great, or the magnitude large and the probability small. *In both magnitude and probability, climate change is an enormous problem. The greenhouse gases that are responsible for it endanger public health and welfare within the meaning of the Clean Air Act.*[36]

EPA summarized some of the overwhelming evidence concerning the effects of climate change on health and welfare that have *already* occurred:

> *Effects on oceans and global sea levels:* "Observations from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increases. Observations show that changes are occurring in the amount, intensity, frequency, and type of precipitation. There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate."[37]
>
> *Loss of Arctic sea ice*: "The latest data from NASA indicate Arctic sea ice set a record low in September 2007, 38 percent below the 1979-2007 average. In September 2008, Arctic sea ice reached its second lowest extent on record." [38]
>
> *Drastic temperature increases*: "U.S. average annual temperatures are approximately 1.25 ˚F (0.69 ˚C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. . . . [T]he rate of warming

[36] *Id*. at 18904 (emphasis added).
[37] *Id.* at 18898.
[38] *Id*.

> increased to 0.58 ˚F/decade (0.32 ˚C/decade) for the period from 1979-2008. [¶] The last ten 5-year periods . . . were the warmest 5-year periods in the 114 years of national records, demonstrating the anomalous warmth of the last 15 years."[39]
>
> *Degradation of water and land resources, agriculture and biodiversity:* "Climate changes are very likely already affecting U.S. water resources, agriculture, land resources, and biodiversity as a result of climate variability and change. A 2008 CCSP report that examined these observed changes concluded: '[t]he number and frequency of forest fires and insect outbreaks are increasing in the interior West, the Southwest, and Alaska. Precipitation, stream flow, and stream temperatures are increasing in most of the continental U.S. The western U.S. is experiencing reduced snowpack and earlier peaks in spring runoff. The growth of many crops and weeds is being stimulated. Migration of plant and animal species is changing the composition and structure of arid, polar, aquatic, coastal, and other ecosystems.'"[40]
>
> *Extreme weather events*: "'Many extremes and their associated impacts are now changing. For example, in recent decades most of North America has been experiencing more unusually hot days and nights, fewer unusually cold days and nights, and fewer frost days. Heavy downpours have become more frequent and intense. . . . The power and frequency of Atlantic hurricanes have increased substantially in recent decades…"[41]

As to the devastating *future* climate change impacts on health and welfare, EPA observed:

> *Increasing temperatures*: "By the end of the century, projected average global warming ranges (compared to average temperature around 1990) varies significantly depending on emissions scenario and climate sensitivity assumptions, ranging from 1.8 to 4.0 ˚C (4.3 to 7.2 ˚F), with an uncertainty range of 1.1 to 6.4 ˚C (2.0 to 11.5 ˚F), according to the IPCC."[42]
>
> *Increased droughts and decreased water availability*: "Drought is expected to increase in the western U.S., where water availability to meet demands for agricultural and municipal water needs is already limited. Another projected impact in the western U.S. is decreased water availability due to a range of interconnected factors. These include: decreases in snowpack, earlier snowmelt resulting in peak winter and decreased summer flows, which will disrupt and limit water storage capacity and will create additional challenges for water allocation among competing uses…"[43]

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[39] *Id*. at 18898-99.
[40] *Id*.
[41] *Id*.
[42] *Id*.
[43] *Id*. at 18900.

Sea level rises: "By the end of the century, sea level is projected to rise between 0.18 and 0.59 meters relative to around 1990 in the absence of increased dynamic ice sheet loss. Recent rapid changes at the edges of the Greenland and West Antarctic ice sheets show acceleration of flow and thinning. [¶¶] As the climate warms, glaciers will lose mass owing to dominance of summer melting over winter precipitation increases, contributing to sea level rise" [44]

Floods: "The U.S. is projected to see an increase in the intensity of precipitation events, which is likely to increase the risk of flood events…"[45]

Increased morbidity and mortality: "Severe heat waves are projected to intensify in magnitude and duration over the portions of the U.S. where these events already occur, with likely increases in mortality and morbidity. The populations most sensitive to hot temperatures are older adults, the chronically sick, the very young, city-dwellers, those taking medications that disrupt thermoregulation, the mentally ill, those lacking access to air conditioning, those working or playing outdoors, and the socially isolated."[46]

Increased spread of diseases: "There will likely be an increase in the spread of several food and water-born pathogens (e.g., Salmonella, Vibrio) among susceptible populations. . . . The primary climate-related factors that affect these pathogens include temperature, precipitation, extreme weather events, and shifts in their ecological regimes."[47]

Crop failures and reduced livestock production: "'[W]ith increased CO_2 and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure . . . [¶] Higher temperatures will very likely reduce livestock production during the summer season, but these losses will very likely be partially offset by warmer temperatures during the winter season. [¶] In addition to human health effects, trophospheric ozone increases as a result of temperature increases and other climatic changes can have significant adverse effects on crop yields, pasture and forest growth and species composition."[48]

Damage to water infrastructure: "Water infrastructure, including drinking water and wastewater treatment plants, and sewer and stormwater management systems, may be at greater risk of flooding, sea level rise and storm surge, low flows, and other factors that could impair functioning."[49]

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[44] *Id*.
[45] *Id*.
[46] *Id*. at 18901.
[47] *Id*.
[48] *Id*. at 18902.
[49] *Id*.

> *Ocean acidification*: "Ocean acidification is projected to continue, resulting in the reduced biological production of marine calcifiers, including corals."[50]

The proposed Endangerment Finding also highlights important findings concerning the international impact of global warming, including the following:

> "The IPCC identifies the most vulnerable world regions as the Arctic, because of high rates of projected warming on natural systems; Africa, especially the sub-Saharan region, because of current low adaptive capacity (e.g., lack of infrastructure and resources) as well as climate change; small islands, due to high exposure of population and infrastructure to risk of sea-level rise and increased storm surge; and Asian mega deltas, due to large populations and high exposure to sea level rise, storm surge and river flooding."[51]

> "On a global basis, according to the IPCC, projected climate change-related impacts are likely to affect the health of millions of people, particularly those with low adaptive capacity, as a result of a number of factors including increased cardio respiratory diseases due to higher concentrations of ground-level ozone brought on by higher temperatures, and by more frequent and intense heat waves."[52]

> "Climate change impacts in certain regions of the world may exacerbate problems that raise humanitarian, trade and national security issues for the U.S. Climate change has been described as a potential threat multiplier regarding national security issues. This is because . . . climate change can aggravate existing problems . . . such as poverty, social tensions, general environmental degradation, and conflict over increasingly scarce water resources."[53]

As demonstrated by the above summary of EPA's own findings, and as overwhelmingly proven by the literature pertaining to the two statutory factors, greenhouse gases endanger public health and welfare. The statutory language concerning the requisite endangerment findings under sections 202(a) (42 U.S.C. § 7521(a)) and 108(a) (42 U.S.C. § 7408(a)) is near-identical. In light of the proposed Endangerment Finding under section 202(a), there can be no doubt that EPA must issue the same endangerment finding under section 108(a)(1)(A)).

The condition of subpart (B) of section 108(a)(1) is also satisfied as greenhouse gases plainly result from numerous and diverse mobile and stationary sources. As EPA has recognized, greenhouse gases are emitted from millions of sources throughout the nation and across all sectors of the economy, including all mobile sources of fossil fuel, home and commercial heating and cooking with oil, natural gas and coal, land use changes, industrial

[50] *Id*.
[51] *Id*. at 18903.
[52] *Id*.
[53] *Id*.

processes such as cement and ammonia manufacturing, and industrial energy generation units.[54] The listing criteria of Section 108(1)(A) and (B) are indubitably met.

D. Because All Prongs of Section 108(a)(1) Are Satisfied, EPA Must Expeditiously Designate Greenhouse Gases as Criteria Air Pollutants

Because greenhouse gases meet the listing provisions under Section 108(a)(1) (42 U.S.C. § 7408(a)), EPA must designate greenhouse gases as criteria air pollutants. When the provisions of subpart (A) and (B) have been met, listing the pollutant and proceeding with the additional requirements of sections 108-110 is mandatory, and EPA lacks any discretion to decline to regulate.

The mandatory nature of EPA's listing obligation was explained by the Second Circuit in *NRDC v. Train*, 545 F.2d 320 (2d Cir. 1976). The Court considered whether EPA had discretion not to proceed with listing lead as a criteria pollutant despite an endangerment finding because subsection (C) states that an air quality criteria is required for any pollutant "for which air quality criteria had not been issued before December 31, 1970, but for which [the Administrator] plans to issue air quality criteria under this section." The court in *Train* held conclusively that no discretion exists: "[o]nce the conditions of [Sections] 108(a)(1)(A) and (B) have been met, the listing of lead and the issuance of air quality standards for lead become mandatory."[55] In the matter at hand, the air pollutants in question are greenhouse gases. If the conditions of the first two criteria are satisfied for greenhouse gases, then the Administrator has no discretion in whether to make an endangerment finding, issue air quality criteria, national pollutant caps, and follow the other mandatory provisions of Clean Air Act sections 108 through 110.

E. EPA Must Comply with the other Mandatory Requirements of Section 108

Once EPA has listed the greenhouse gases as criteria air pollutants, the EPA must issue air quality criteria specifying the impact of those pollutants on the public health and welfare. Section 108(a)(2) provides as follows:

> Shall issue air quality criteria for an air pollutant within 12 months after [EPA] has included such pollutant in a list under paragraph (1). Air quality criteria for an air pollutant *shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of such pollutant in the ambient air*, in varying quantities. The criteria for an air pollutant, to the extent practicable, shall include information on –
>
> (A) those variable factors (including atmospheric conditions) which of themselves or in combination with other factors may alter the effects on public health or welfare of such air pollutant;
>
> (B) the types of air pollutants which, when present in the atmosphere, may interact with such pollutant to produce an adverse effect on public health or welfare; and

[54] 73 Fed. Reg. at 44401, 44403, 44429-437, 44453-454, 44462, 44468; *see also* 74 Fed. Reg. 18886, 18907.
[55] *Train*, 545 F.2d. at 328.

(C) any known or anticipated adverse effects on welfare.

42 U.S.C. 7408(a)(2) (emphasis added).

Simultaneously with the release of the air quality criteria, section 108(b)(1) requires EPA to issue "information on air pollution control techniques, which information shall include data relating to the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impact of the emission control technology."[56]

Additionally, section 108(f) requires EPA to:

> Publish and make available to appropriate Federal, State, and local environmental and transportation agencies not later than one year after November 15, 1990, and from time to time thereafter . . . information regarding processes, procedures, and methods to reduce or control pollutants in transportation; reduction of mobile source related pollutants; reduction of impact on public health.

Section 108(f) provides a non-exhaustive list of sixteen categories of information that EPA must provide, after consultation with the Secretary of Transportation and a public comment period, "regarding the formulation and emission reduction potential of transportation control measures related to criteria pollutants and their precursors."

Again simultaneously with publication of the air quality criteria, EPA must also publish proposed air quality standards for the pollutant pursuant to section 109 (42 U.S.C. § 7409), as discussed below.

II. EPA Must Establish Science-Based National Pollution Caps to Protect the Public Health and Welfare

Once a pollutant is listed pursuant to section 108(a)(1), EPA must establish national pollution caps sufficient to protect the public health and welfare. Specifically, EPA "shall publish, simultaneously with the issuance of such criteria and information, proposed national primary and secondary ambient air quality standards for any such pollutant" (NAAQS) in order to protect the public health and welfare.[57] EPA must finalize the national pollutant caps no later than 90 days from the initial publication, following public review and comment on the proposal.[58]

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[56] Clean Air Act § 108(b)(1), 42 U.S.C. § 7408(b)(1) (2008).

[57] Clean Air Act § 109(a)(2), 42 U.S.C. § 7409(a)(2) (2008). In the Advance Notice of Proposed Rulemaking for greenhouse gases, the EPA advanced the theory that it might have discretion to decline to set primary and/or secondary pollution caps for greenhouse gases, either because there are no public health or welfare impacts at current ambient greenhouse gas concentrations, or because health impacts are indirect and "largely incidental" to welfare impacts. 73 Fed. Reg. at 44426-44427. EPA itself has now definitively rejected these contentions in the proposed Endangerment Finding. EPA must issue both primary and secondary pollution caps for greenhouse gases.

[58] Clean Air Act § 109(a)(1)(B), 42 U.S.C. § 7409(a)(1)(B) (2008).

The primary national pollution caps (NAAQS) are "ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health."[59]

The secondary national pollution caps (NAAQS) "shall specify a level of air quality the attainment and maintenance of which in the judgment of the Administrator, based on such criteria, is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air."[60] As discussed above, the Clean Air Act defines "welfare" as:

> All language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.[61]

As discussed above, the scientific literature reflects, and EPA has recognized, a wide array of current and projected global and U.S. health and welfare effects. The only remaining question is the level at which the national pollution limits must be set to adequately protect the public health and welfare.

A. Pollutants Subject to this Petition

The sources and properties of the pollutants subject to this petition are discussed extensively in the IPCC's Fourth Assessment Report and in the other primary source documents listed above. Some of the key properties of the petitioned pollutants are summarized in Table 1.

[59] Clean Air Act § 109(b)(1), 42 U.S.C. § 7409(b)(1) (2008).
[60] Clean Air Act § 109(b)(2), 42 U.S.C. § 7409(b)(2) (2008).
[61] Clean Air Act § 302(h), 42 U.S.C. § 7602(h) (2008).

Table 1: Key Properties of Petitioned Pollutants

Pollutant[a]	Atmospheric Lifetime (years)	GWP[b] 20-yr	GWP 100-yr	GWP 500-yr	Pre-Industrial Concentration	Current Concentration[c]
Carbon Dioxide (CO_2)	*See note d*	1	1	1	275-285 ppm[e]	385.2[f] ppm (2008)
Methane (CH_4)	12	72	25	7.6	715 ppb[g]	1797[f] ppb (2008)
Nitrous Oxide (N_2O)	114	289	298	153	270 ppb	321.8[f] ppb (2008)
Hydrofluorocarbons (HFCs)[j]	1.4-270					
HFC-125	29	6,350	3,500	1,100	0	3.7 ppt[i]
HFC-134a	14	3,830	1,430	435	0	35 ppt
HFC-152a	1.4	437	124	38	0	3.9 ppt
HFC-23	270	12,000	14,800	12,200	0	18 ppt
Perfluorocarbons (PFCs)[j]						
PFC-14	50,000	5,210	7,390	11,200	0	74 ppt
PFC-116	10,000	8,630	12,200	18,200	0	2.9 ppt
Sulfur hexafluoride (SF_6)	3,200	16,300	22,800	32,600	0	5.6 ppt
Nitrogen Trifluoride	740	12,300	17,200	20,700	0	0.454[k] ppt (2008)

[a] Unless otherwise noted, data from P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing, in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Solomon, S., et al. eds., Cambridge University Press 2007).

[b] direct, global mean Global Warming Potential (see discussion of GWPs, *supra*).

[c] 2005 value unless otherwise noted.

[d] It is not possible to give a single lifetime for CO_2, but research has highlighted its long residence time. While approximately half of the carbon emitted is removed by the natural carbon cycle within a century, a substantial fraction of anthropogenic CO_2 will persist in the atmosphere for several millennia. *See, e.g.*, A. Montenegro et al., *Long Term Fate of Atmospheric Carbon*, 34 GEOPHYS. RES. LETT. L19707 (2007) (25% of emitted CO_2 will have an atmospheric lifetime of more than 5000 years); S. Solomon et al., *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 PNAS 1704 (2009).

[e] parts per million.

[f] World Meteorological Organization (WMO), WMO Greenhouse Gas Bulletin. No. 5: 23 (Nov. 2009), available at http://www.wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin html.

[g] parts per billion.

[i] parts per trillion.

[j] Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. Appendix A provides a complete list of the petitioned HFCs and PFCs. The compounds with the greatest contribution to global warming are included here for illustrative purposes.

[k] Weiss et al., *supra* note 62.

Nitrogen trifluoride is the only gas not discussed in the proposed Endangerment Finding, and not extensively treated in the AR4 and other source documents, as it has only recently been measured in the atmosphere. Nitrogen trifluoride is used in the electronics industry for equipment cleaning, for the etching of microcircuits, and for manufacturing liquid crystal flat panel displays and thin-film photovoltaic cells.[62] It is not included in the reporting requirements or restricted under the U.S. Framework Convention on Climate Change process, and has therefore increasingly been used as a replacement for PFCs which are covered under the Convention and Kyoto Protocol.[63] Scientists have recently measured nitrogen trifluoride levels of 0.454 ppt, a quasi-exponential growth from about 0.02 ppt in 1978.[64] The rise corresponds to about 620 metric tons of emissions per year, or about 16% of the poorly-constrained global production estimate of 4,000 metric tons per year.[65] As discussed below, although nitrogen trifluoride is currently a small contributor to global warming, EPA must regulate it due to its increasing use, high global warming potential, and long atmospheric lifetime.[66]

B. The Latest Scientific Knowledge Supports a National Pollution Limit for Carbon Dioxide of No More than 350 Parts per Million

The national pollution cap established by EPA must be science-based and sufficient to protect the public health and welfare. The Clean Air Act also embodies a precautionary approach of considering the likelihood that emerging science will demonstrate a need for a lower threshold level as uncertainties are resolved. This idea is explicitly invoked through the "adequate margin of safety" language of section 109(b)(1).

As the Supreme Court stated in *Whitman v. American Trucking Associations*, "EPA, 'based on' the information about health effects contained in the technical 'criteria' documents compiled under section 108(a)(2), 42 U.S.C. § 7408(a)(2), is to identify the maximum airborne

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[62] R. F. Weiss et al., *Nitrogen Trifluoride in the Global Atmosphere*, 35 GEOPHYS. RES. LETT. L20821 (Oct. 2008), *available at http://www.agu.org/pubs/crossref/2008/2008GL035913.shtml.*

[63] *Id.*

[64] *Id.*

[65] *Id.*

[66] In the proposed Endangerment Finding, EPA determined without question that the six other greenhouse gases subject to this petition cause and contribute to air pollution even though the individual contribution of any one greenhouse gas may be deemed small: "Importantly, because no single greenhouse gas source category dominates on the global scale, many (if not all) individual greenhouse gas source categories could appear too small to matter, when in fact, they could be very significant contributors in terms of both absolute emissions or in comparison to other similar source categories within the U.S. If the U.S. and the rest of the world are to combat the risks associated with global climate change, contributors must do their part even if their contributions to the global problem, measured in terms of percentage, are smaller than typically encountered when tackling solely regional or local environmental issues." 74 Fed. Reg. 18907. For that reason, and because of the potency and longevity of individual greenhouse gases, the Administrator determined that if she were to evaluate any of the greenhouse gases as a separate air pollutant, she would nonetheless find them to "cause or contribute" to air pollution. For example, the Administrator found methane to contribute to air pollution under section 202(a) even though in 2006, methane emissions from section 202(a) source categories were 0.03 percent of total U.S. greenhouse gas emissions and less than 0.01 percent of total global greenhouse gas emissions in 2005. 74 Fed. Reg. 18908. Similarly, because of nitrogen trifluoride's long atmospheric lifetime (740 years), extremely potent global warming potential (17,200 times more powerful than carbon dioxide over a 100 year period) and exponential increase in atmospheric concentrations in recent years, EPA should arrive at the same conclusion here.

concentration of a pollutant that the public health can tolerate, decrease the concentration to provide an 'adequate' margin of safety, and set the standard at that level."[67] On remand, the Court of Appeals for the District of Columbia held that "EPA must err on the side of caution, . . . setting the NAAQS at whatever level it deems necessary and sufficient to protect the public health with an adequate margin of safety, taking into account both the available evidence and the inevitable scientific uncertainties."[68]

In considering the impacts from CO_2 and the other greenhouse gases, the EPA must consider, and accurately reflect, the "latest scientific knowledge."[69] The latest scientific knowledge supports a national pollution cap of no more than 350 parts per million for CO_2. Leading climate scientists, publishing in a peer-reviewed scientific journal, have concluded that the present concentration of 385 ppm CO_2, is "already in the dangerous zone."[70] Their findings are briefly summarized as follows:

> If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that. The largest uncertainty in the target arises from possible changes of non-CO_2 forcings. An initial 350 ppm CO_2 target may be achievable by phasing out coal use except where CO_2 is captured and adopting agricultural and forestry practices that sequester carbon. If the present overshoot of this target CO_2 is not brief, there is a possibility of seeding irreversible catastrophic effects.[71]

Atmospheric CO_2 concentrations must be reduced quickly: "Indeed, if the world continues on a business-as-usual path for even another decade without initiating phase-out of unconstrained coal use, prospects for avoiding a dangerously large, extended overshoot of the 350 ppm level will be dim."[72]

The many other statements from scientists and lines of evidence in support of a pollution cap of no more than 350 ppm CO_2 include the following:

- Dr. Rajendra Pachauri, chairman of the Intergovernmental Panel on Climate Change, personally endorsed a 350ppm target: "What is happening, and what is likely to happen, convinces me that the world must be really ambitious and very determined at moving toward a 350 target."[73]

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[67] *Whitman*, 531 U.S. at 465.
[68] *American Trucking Associations, Inc. v. EPA*, 283 F.3d 355, 378 (D.C. Cir. 2002).
[69] Clean Air Act § 108(a)(2), 42 U.S.C. § 7408(a)(2).
[70] J. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?*, 2 OPEN ATMOSPHERIC SCI. J. 217, 218 (2008).
[71] *Id.* at 217. Because climate forcing from anthropogenic non-CO_2 greenhouse emissions are approximately offset by the cooling effect of anthropogenic aerosol emissions, Hansen et al. (2008) consider future CO_2 change as approximating the net human-made forcing change, with several caveats.
[72] *Id.* at 227.
[73] Marlow Hood, *Top UN Climate Scientist backs Ambitious CO_2 Cuts*, AGENCE FRANCE PRESS, Aug. 28, 2009, *available at* http://www mg.co.za/article/2009-08-25-top-un-climate-scientist-backs-ambitious-co2-cuts; *see also*

- A United Nations project to quantify the financial costs of climate change on nature concluded that atmospheric CO_2 must be reduced to below 350 ppm to save the world's coral reefs:

  > Coral reef losses accelerated significantly once atmospheric concentrations of CO_2 reached around 320 ppm due to temperature-induced coral bleaching. These losses were compounded by excessive CO_2 dissolution in sea water. This caused ocean acidification, which in turn hampers reef regeneration. Scientific consensus has emerged that atmospheric CO_2 concentrations need to be "significantly below 350 ppm" for the long-term viability of coral reefs (Royal Society 2009)....[¶] Even current levels of atmospheric CO_2 are too high for coral reef survival. We need large and permanent removals of CO_2 from the atmosphere…. Accepting any stabilization target above 350 ppm CO_2 really means that society has made a decision to make do without coral reefs. It is therefore also a decision to accept the serious consequences of coral reef loss on biodiversity, on sea fisheries around the world, and on the half billion people who depend directly on coral reefs for their livelihoods. Removing CO_2 has thus become an imperative for survival.[74]

- Twenty top climate scientists recently issued an open letter to President Obama and Congress to "call attention to the large difference between what U.S. politics now seems capable of enacting [targeting reduction to 450ppm] and what scientists understand is necessary to prevent climatic disruption and protect the human future…We and many others are of the view that these objectives [limiting CO_2 to 450 ppm and global temperature increase to 2° C] are inadequate to sustain the integrity of global climate and to hold the risk of ruinous climatic change to an acceptably low level."[75]

The best available science now indicates unequivocably that stabilizing CO_2 at 450 ppm with the goal of limiting warming to 2°C is not "safe" and will not protect public health and welfare. In 2001, the Intergovernmental Panel on Climate Change (IPCC) identified five "Reasons For Concern" in its Third Assessment Report to illustrate the temperature range at which impacts may be considered dangerous.[76] Relationships between the impacts reflected in each Reason For Concern and increases in global mean temperature were portrayed in a "burning embers" diagram, which reflected the severity of risk from rising temperature through gradations in color from white (no or little risk) to yellow (moderately significant risk) to red (substantial or

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Yale Environment 360, *Amid Mounting Hope, a Voice of Hope for Copenhagen*, Nov. 4, 2009, http://www.e360.yale.edu/content/feature.msp?id=2206 (last visited Dec. 1, 2009).

[74] THE ECONOMICS OF ECOSYSTEM BIODIVERSITY (TEEB), TEEB CLIMATE ISSUES UPDATE (Sept. 2009), *available at* http://www.teebweb.org/InformationMaterial/PresentationTools/tabid/1053/language/en-US/Default.aspx.

[75] Dean Abrahamson, An Open Letter to the President and Members of Congress Strong Leadership Needed Now on Climate (June 23, 2009).

[76] IPCC, CLIMATE CHANGE 2001: SYNTHESIS REPORT, SUMMARY FOR POLICYMAKERS 11 (2001), *available at* http://www.ipcc.ch/pdf/climate-changes-2001/synthesis-spm/synthesis-spm-en.pdf. The five Reasons For Concern identified in the Third Assessment Report are: 1) risks to unique and threatened systems; 2) risks of extreme weather events; 3) distribution of impacts; 4) aggregate impacts; and 5) risks of large scale discontinuities.

severe risk).[77] Depending on the Reason For Concern, the IPCC predicted that substantial impacts or risks (transition from yellow to red) would occur with a temperature rise 1–4°C above current levels.[78]

Since the release of the Third Assessment Report, scientific understanding of the vulnerability of the climate to temperature rise has evolved considerably.[79] Based on new findings in the growing scientific literature, the burning embers diagram was revised in 2008 to reflect the dangerous risks posed by smaller increases in temperature than identified in the Third Assessment Report.[80] In the updated burning embers diagram, the IPCC now predicts that substantial impacts or risks occur at or near current temperature levels for a number of the Reasons For Concern.[81] As reflected in the updated Reasons for Concern, a 2°C temperature increase from pre-industrial levels (or 1.4°C increase from 1990 levels) is well past the point where severe and irreversible impacts will occur.[82]

It is now estimated that a mean global temperature increase of 1.5°C above pre-industrial levels has the potential to trigger irreversible melting of the Greenland ice sheet, a process that would result in an eventual seven meter sea level rise over and above that caused by thermal expansion of the oceans, and that could potentially cause an additional sea level rise of 0.75 meters, as soon as 2100.[83] Specific consequences of a 2°C temperature rise from pre-industrial levels include the loss of 97 percent of the world's coral reefs and the transformation of 16 percent of global ecosystems. Indeed, given increased confidence that a 1–2°C increase poses significant risks to many unique and threatened systems, including many biodiversity hotspots, the updated burning embers diagram indicates substantial impacts and/or moderate risks from warming that has already occurred.[84] At a 2°C temperature rise, approximately one to three billion people would experience an increase in water stress, sea level rise and cyclones would displace millions from the world's coastlines, and agricultural yields would fall in the developed world.[85] In the Arctic, ecosystem disruption is predicted upon expectations of a complete loss of summer sea ice, with only 42 percent of the tundra remaining stable. Such a disruption would

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[77] *Id.*; *see also* Joel B. Smith et al., *Assessing Dangerous Climate Change Though an Update of the Intergovernmental Panel on Climate Change (IPCC) "Reasons for Concern,"* 106 PROC. OF THE NAT'L ACAD. SCI. 4133 (2009), *available at* http://www.pnas.org/content/early/2009/02/25/0812355106.abstract.

[78] IPCC, *supra* note 76. The Reasons For Concern assessed impacts from a baseline of 1990 temperature levels rather than pre-industrial levels. Because pre-industrial warming until 1990 was 0.6°C, an impact resulting from a temperature rise of 1°C equates to a 1.6°C rise from pre-industrial levels. *Id*.

[79] *See* Smith, *supra* note 77, at 4133, 4137.

[80] *See id.* An updated burning embers diagram was omitted from the 2007 Fourth Assessment Report due to opposition from the United States, China, Russia, and Saudi Arabia. Because the Assessment Report is a consensus document, these countries were able to prevent the inclusion of an updated diagram despite the insistence by New Zealand, small islands states, Canada, Germany, and the United Kingdom that inclusion of an updated burning embers diagram was essential. *See also* Andrew C. Revkin, *Why 2007 I.P.C.C. Report Lacked 'Embers'*, N.Y. TIMES, Feb. 26, 2009, *available at* http://dotearth.blogs nytimes.com/2009/02/26/why-2007-ipcc-report-lacked-embers.

[81] *See id.*

[82] Smith, *supra* note 77, at 3.

[83] Rachel Warren, *Impacts of Global Climate Change at Different Annual Mean Global Temperature Increases*, *in* AVOIDING DANGEROUS CLIMATE CHANGE 95 (2006). Unlike the IPCC's Reason For Concern, Warren assessed impacts from temperature rise from pre-industrial levels, not 1990 levels.

[84] Smith, *supra* note 77, at 3.

[85] *See* Warren, *supra* note 83, at 98.

severely affect northern peoples and cause the extinction of the polar bear and many other species. Moreover, because Arctic ice functions to reflect heat back into the atmosphere, its loss would allow more sunlight to heat the Arctic Ocean, creating a negative feedback loop that would further accelerate the melting of the Greenland ice sheet. As the devastating and irreversible impacts resulting from a 2°C mean global temperature rise are clearly dangerous to public health and welfare, the commonly referenced 450 ppm CO_2 stabilization and 2°C targets are not adequate.

In light of the scope and irreversibility of the consequences of overshooting a 2°C threshold, the risk tolerance for such an outcome should be extremely low. The risk of overshooting a 2°C threshold is 50–82 percent at stabilization levels of 450–550 ppm CO_2eq.[86] On the other hand, stabilizing greenhouse gas concentrations at 350 ppm CO_2eq would reduce the mean probability of overshooting a 2°C temperature rise to 7 percent.[87]

Ultimately, it may well be necessary to reduce atmospheric CO_2 to below 350 ppm. In September 2008, the director of the Potsdam Institute for Climate Impact Research in Germany, John Schellnhuber, told the *Guardian* that proposed GHG reduction targets were insufficient, and that a reduction of CO_2 to the pre-industrial level of 280 ppm would be required to ensure a stable climate.[88] Schellnhuber stated, "It is a very sweeping argument, but nobody can say for sure that 330ppm is safe. Perhaps it will not matter whether we have 270ppm or 320ppm, but operating well outside the [historic] realm of carbon dioxide concentrations is risky as long as we have not fully understood the relevant feedback mechanisms."[89]

Protection of the Arctic and other particularly vulnerable regions such as coastal areas and low lying islands may also require a lower level. Hansen et al. (2008) concluded:

> Stabilization of Arctic sea ice cover requires, to first approximation, restoration of planetary energy balance. Climate models driven by known forcings yield a present planetary energy imbalance of +0.5-1 W/m^2. Observed heat increase in the upper 700 m of the ocean confirms the planetary energy imbalance, but observations of the entire ocean are needed for quantification. CO_2 amount must be reduced to 325-355 ppm to increase outgoing flux 0.5-1 W/m^2, if other forcings are unchanged. A further imbalance reduction, and thus CO_2 ~300-325 ppm, may be needed to restore sea ice to its area of 25 years ago.[90]

Because current evidence indicates that limiting atmospheric CO_2 to no more than 350 ppm is necessary to protect public health and welfare, Petitioners request both a primary and

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[86] Malte Meinshausen, *What Does a 2°C Target Mean for Greenhouse Gas Concentrations? A Brief Analysis Based on Multi-Gas Emission Pathways and Several Climate Sensitivity Uncertainty Estimates, in* AVOIDING DANGEROUS CLIMATE CHANGE 268, 270 (2006).
[87] *Id.*
[88] David Adam, *Roll Back Time to Safeguard Climate, Expert Warns: A Return to Pre-Industrial Levels of Carbon Dioxide Urged as the Only Way to Prevent the Worst Impacts of Global Warming*, THE GUARDIAN, Sept. 15 2008, *available at* http://www.guardian.co.uk/environment/2008/sep/15/climatechange.carbonemissions.
[89] *Id.*
[90] *Id.* at 226 (internal citations omitted).

secondary national pollution limit (NAAQS) of no more than 350 ppm CO_2. The EPA may be required to adjust the pollution limit downward as further information becomes available.

C. Pollution Limits for the Other Petitioned Pollutants

Petitioners request that EPA issue national pollution limits for each additional greenhouse gas as specified in Table 2: Petitioned National Pollution Limits. Petitioners recognize that in the proposed endangerment finding, EPA proposes to regulate the six greenhouse gases together, and that the EPA has flexibility with regard to regulating the petitioned greenhouse gases either individually or as a group.[91] Petitioners also recognize the importance of the CO_2-eq metric[92] in many circumstances, and the potential administrative efficiency benefits that can be achieved through the regulation of greenhouse gases as a group as opposed to individually. EPA could also utilize a combination of approaches, so long as the chosen approach facilitates achievement of the Clean Air Act's objectives and is neither arbitrary nor capricious. The Clean Air Act's flexibility in this regard allows differentiated prioritization and achievement of various policy objectives.

However, setting national pollution caps for each of the greenhouse gases individually allows for greater precision in achieving a number of policy objectives. For example, methane is particularly effective at warming the Arctic in part because, in addition to being a potent greenhouse gas in its own right, it is also an ozone precursor. Tropospheric ozone, unlike other greenhouse gases, absorbs both infrared radiation and shortwave radiation (visible light). Thus, tropospheric ozone is a powerful warming agent over highly reflective surfaces like the Arctic in the springtime, because it traps shortwave radiation from the sun both as it enters the Earth's atmosphere and when it is reflected back out again by snow and ice. Reducing global methane emissions will reduce ozone concentrations in the Arctic, providing a double benefit to the region.[93] Deep and rapid reductions in methane are needed in order to save the seasonal Arctic ice pack and Arctic species.[94] Stated another way, a given volume of methane reductions with

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[91] "Air pollutant" is defined by the Clean Air Act as follows:

> The term "air pollutant" means any air pollution agent or *combination of such agents*, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term "air pollutant" is used. Clean Air Act § 302(g), 42 U.S.C. 7602(g) (2008) (emphasis added).

[92] Greenhouse gases differ in their warming influence on the global climate system due to both their different radioactive properties and different lifetimes in the atmosphere. Therefore, a common method is needed to compare the gases. The most widely used method for doing so is CO_2-eq, which expresses a common warming influence based on the radiative forcing of CO_2. The term "CO_2-eq emissions" refers to the amount of CO_2 that would cause the same time-integrated radiative forcing, over a given time horizon, as an emitted amount of a long lived greenhouse gas or a mixture of greenhouse gases. The CO_2-eq emission is obtained by multiplying the emission of a greenhouse gas by its Global Warming Potential (GWP) for the given time horizon. L. BERNSTEIN ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 36 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

[93] *See, e.g.*, J. Hansen et al., *Climate Change and Trace Gases*, 365 PHIL. TRANS. R. SOC. A. 1925 (2007), *available at* http://pubs.giss nasa.gov/docs/2007/2007_Hansen_etal_2.pdf; Shindell, D., *Local and Remote Contributions to Arctic Warming*, GEOPHYS. RES. LETT. 34, L14704 (July 20, 2007), *available at* http://www.agu.org/pubs/crossref/2007/2007GL030221.shtml.

[94] *Id.*

the same CO_2-eq measure as a given volume of CO_2 emissions reductions would have a greater impact on Arctic warming in the short term.

The EPA must carefully consider such issues in order to ensure that the public health and welfare is protected with an adequate margin of safety.[95] As the climate crisis rapidly worsens, it is essential to regulate at least some of the pollutants individually to protect particularly vulnerable regions such as the Arctic or prevent or ameliorate certain other impacts. And while the Clean Air Act grants discretion to EPA as to whether to regulate individual pollutants or groups of pollutants, ultimately EPA must ensure that its choice allows it to achieve the substantive goals of the Clean Air Act, including Section 109's mandate to protect the public health with an adequate margin of safety.

For these reasons, Petitioners request individual national pollution limits for each pollutant at the levels specified in Table 2.

[95] Similar issues were discussed by one commentator as follows:

> Comparing [greenhouse gases] is not a straightforward issue for several reasons. Perhaps the most fundamental reason is the gases' various lifetimes in the atmosphere. While the radiative forcing of methane emissions lasts for a decade or two, the radiative forcing of carbon dioxide lasts for centuries. Additional difficulties are raised due to the complexities in the relationship between radiative forcing and a more relevant metric of climate change: temperature change. Moreover, as pointed out by the IPCC (2001b, Ch. 19), there is evidence that the impact from emissions of various GHGs in some cases (such as impact on ecosystems) depends more on the rate of change of temperature rather than changes in level. In other cases (such as sea-level rise), impacts may depend more on the integrated change of surface temperature. Taking into account possible threshold values of climate change is also important. The functional form of damages will hence affect the efficient trade-off between various GHGs. Furthermore, because of the nonlinearities of the climate system, the evaluation of the present emissions of some GHGs will depend on which future background scenario is used (see, e.g., Smith and Wigley, 2000). Because of all these issues, designing an index to compare today's emissions of various GHGs is a challenging task. Odd Godal, *The IPCC's Assessment of Multidisciplinary Issues: The Case of Greenhouse Gas Indices*, 58 CLIMATIC CHANGE 243 (Nov. 2003).

Table 2: Petitioned National Pollution Limits

Pollutant[a]	Lifetime (years)	Pre-Industrial Concentration	Current Concentration[b]	Primary Pollution Limit	Secondary Pollution Limit
Carbon Dioxide (CO_2)	*See note c below*	275-285 ppm[d]	385.2[e] ppm (2008)	350 ppm	350 ppm
Methane (CH_4)	12	715 ppb[f]	1797[e] ppb (2008)	715 ppb	715 ppb
Nitrous Oxide (N_2O)	114	270 ppb	321.8[e] ppb (2008)	270 ppb	270 ppb
Hydrofluorocarbons (HFCs)[h]	1.4-270				
HFC-125	29	0	3.7 ppt[g]	1 ppt	1 ppt
HFC-134a	14	0	35 ppt	1 ppt	1 ppt
HFC-152a	1.4	0	3.9 ppt	1 ppt	1 ppt
HFC-23	270	0	18 ppt	1 ppt	1 ppt
Perfluorocarbons (PFCs)[h]					
PFC-14	50,000	0	74 ppt	75 ppt	75 ppt
PFC-116	10,000	0	2.9 ppt	3 ppt	3 ppt
Sulfur hexafluoride (SF_6)	3,200	0	5.6 ppt	5.7 ppt	5.7 ppt
Nitrogen Trifluoride (NF_3)	740	0	0.454[i] ppt (2008)	0.46 ppt	0.46 ppt

[a] Unless otherwise noted, data from P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing, in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Solomon, S., et al. eds., Cambridge University Press 2007).

[b] 2005 value unless otherwise noted.

[c] It is not possible to give a single lifetime for CO_2, but research has highlighted its long residence time. While approximately half of the carbon emitted is removed by the natural carbon cycle within a century, a substantial fraction of anthropogenic CO_2 will persist in the atmosphere for several millennia. *See, e.g.*, A. Montenegro et al., Long term fate of atmospheric carbon, *Geophys. Res. Lett.*, 34, L19707, doi:10.1029/2007GL030905 (2007) (25% of emitted CO_2 will have an atmospheric lifetime of more than 5000 years); S. Solomon et al., Irreversible climate change due to carbon dioxide emissions, *PNAS* 106: 1704-1709 (2009).

[d] parts per million.

[e] World Meteorological Organization (WMO). 2009. WMO Greenhouse Gas Bulletin. No. 5: 23 November 2009. Available at http://www.wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin.html.

[f] parts per billion.

[g] parts per trillion.

[h] Petitioners seek regulation of all HFCs and PFCs for which either significant concentrations or large trends in concentrations have been observed or a clear potential for future emissions has been identified. The compounds with the greatest contribution to global warming are included here for illustrative purposes.

[i] Weiss et al. 2008, *supra* note 62.

As with CO_2, because current evidence indicates these levels are necessary to protect both the public health and welfare from global warming and climate disruption, Petitioners seek these levels as both the primary and secondary national pollution limits.

Methane and nitrous oxide are the two most important greenhouse gases after carbon dioxide, and the deep and rapid reduction of both of these pollutants is an essential part of any action plan to stabilize the climate system. Petitioners thus request that EPA set the national pollution limits for these gases at the natural level that existed prior to significant human-caused emissions, 715 ppb for methane and 270 ppb for nitrous oxide. Because methane has a relatively short atmospheric lifetime of 12 years, this level, though ambitious, will be achievable if combined with other greenhouse reduction measures sufficient to slow and reverse climate feedbacks, such as the release of methane from melting Arctic permafrost, which if left unchecked may overwhelm other reduction efforts. While nitrous oxide remains in the atmosphere for 114 years, an ambitious reduction target is warranted due to its high global warming impact and importance to overall greenhouse reduction efforts.

Significant reductions in the HFCs, which have relatively short atmospheric lifetimes, are also needed. Thus the petitioned pollutant limit of 1 ppt for each of the HFCs, which are entirely man-made and do not occur naturally in the environment, would require release of these chemicals to be virtually eliminated, resulting in an eventual return to near zero concentration of these greenhouse gases in the atmosphere.

The extremely long atmospheric lifetimes of the PFCs, sulfur hexafluoride, and nitrogen trifluoride means that their atmospheric concentrations will remain elevated for many hundreds to thousands of years even if all emissions end immediately. Thus the petitioned pollution limits are set at close to current levels, which would require the phase out of these pollutants in the short term, but at least for the next centuries would only result in stabilization of current concentrations of these pollutants, until and unless a method for removing these chemicals from the atmosphere is developed.

III. EPA Must Expeditiously Facilitate the State Implementation Planning Process

After EPA adopts national pollution limits, each "[s]tate shall, after reasonable notice and public hearings, adopt and submit to the Administrator . . . a plan which provides for implementation, maintenance, and enforcement of [these limits]."[96] Through this "cooperative federalism" structure, the Clean Air Act delegates the primary responsibility for choosing the steps necessary to achieve and maintain the national pollution limits to the states. The state implementation planning process effectively combines the benefits of both state and federal involvement in greenhouse gas reductions. The successful state implementation planning process should be mobilized immediately to address the climate crisis.

A. Overview of the State Implementation Planning Process

A state implementation plan is a comprehensive strategy devised by each state to achieve or maintain the national pollution limits. Generally, a state begins the state implementation

[96] Clean Air Act § 110(a)(1), 42 U.S.C. § 7410 (a)(1) (2008).

planning process by creating an inventory of all emissions sources in the state.[97] It then determines the amount of emissions reductions that will be necessary to attain or, if it is already in attainment, maintain the ambient levels required by the national pollution limits through air quality modeling.[98] After determining the amount of reductions necessary, the state outlines a suite of measures designed to achieve those reductions, including emissions limitations, monitoring requirements, enforcement mechanisms, and schedules for compliance.[99] The state formally adopts these measures into the state implementation plan after public comment.[100]

The states must submit their completed state implementation plans to EPA for approval.[101] EPA must approve state implementation plans if they show that the state will attain or maintain the national pollution limits,[102] although EPA may also partially or conditionally approve a state implementation plan and require revisions.[103] If a state fails to submit a state implementation plan that demonstrates attainment or maintenance of the national pollution limits, EPA must apply a variety of funding and compliance sanctions.[104]

If a state has failed to submit an approvable state implementation plan two years after the deadline, EPA must issue a federal implementation plan.[105] A federal implementation plan is "a plan (or portion thereof) promulgated by the Administrator to fill all or a portion of a gap or otherwise correct all or a portion of an inadequacy in a State implementation plan . . . and provides for attainment of the relevant national [pollution limit]."[106] Therefore, if the states fail to do their job under section 110, EPA must create, and the states must implement, a federal plan in order to attain or maintain the national pollution limit.

B. State Implementation Plans are Well Suited to Reducing Greenhouse Gas Emissions

Once EPA sets national pollution limits for greenhouse gases, the states must update their state implementation plans to achieve or maintain those limits as they do for the other criteria air pollutants. Although greenhouse gases present a different set of concerns than the existing criteria pollutants, the state implementation plan process is fully able to address these unique concerns and is well suited to effectively reducing greenhouse gas emissions.[107]

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[97] *See* Clean Air Act § 172, 42 U.S.C. § 7502(c)(3) (2008) (for nonattainment areas); 40 C.F.R. § 51.114 (for attainment areas).
[98] Clean Air Act § 110(a), 42 U.S.C. § 7410(a) (2008); Doremus et al., *supra* note 6.
[99] Clean Air Act § 110(a)(2), 42 U.S.C. § 7410(a)(2) (2008).
[100] *Id.* § 7410(a)(1).
[101] *Id.*
[102] *Id.* § 7410(k)(3).
[103] *Id.* § 7410(k)(4).
[104] Clean Air Act § 179, 42 U.S.C. § 7509 (2008).
[105] Clean Air Act § 110(c)(1), 42 U.S.C. § 7410(c)(1) (2008).
[106] Clean Air Act § 302(y), 42 U.S.C. § 7602(y) (2008).
[107] EPA's proposed Tailoring Rule has already commenced the process of tailoring greenhouse gas permitting procedures required under the Clean Air Act's Title V and prevention of significant deterioration program, and can create similar procedures to allow an efficient and streamlined process to amend and implement state implementation plans, beginning with the regulation of large emitters and including smaller emitters as soon as administratively possible. *See* 74 Fed. Reg. 55292.

Unlike the existing criteria air pollutants, greenhouse gases are globally dispersed, so that attainment of a national pollution limit for greenhouse gases is a global rather than merely a local concern. Therefore, instead of focusing solely on achieving local air quality standards, state implementation plans for greenhouse gases must focus on achieving each state's proportional share of greenhouse pollution reductions needed to attain the national pollution limit. EPA will need to allocate proportional emissions reduction targets to the states; they, in turn, will demonstrate through state implementation plans how they will integrate the federal minimum requirements by means of their own initiatives to achieve that proportional share of national emissions reductions.

Under the Clean Air Act, a state implementation plan must: 1) monitor, compile, and analyze data on ambient air quality; 2) include enforceable emission limitations and other control measures, means, or techniques (which may include economic incentives such as fees, marketable permits, and auctions of emission rights), as well as schedules and timetables for compliance; and 3) include a program to provide for enforcement of emission reduction measures.[108]

Many states are already implementing or are well on their way to completing greenhouse gas reduction plans, and their success to date illustrates the feasibility of developing state implementation plans for greenhouse gases. Many of the required state implementation plan elements are already included in these climate change action plans. As of August 2009, at least forty-seven states have completed or are completing a GHG inventory, thirty-eight are drafting or have drafted climate action plans, and twenty-three states have adopted emissions reduction targets.[109] These existing state climate change plans will undoubtedly form the basis of future greenhouse gas state implementation plans.

In its Advance Notice of Proposed Rulemaking on greenhouse gases, EPA questioned whether it might be unable to approve state implementation plans for greenhouse gases because it is not possible for any individual state (or country) to attain an atmospheric greenhouse gas limit solely through its own efforts.[110] In the proposed Endangerment Finding, however, EPA fully recognized that such a concern is misplaced; because of the global nature of greenhouse emissions, their treatment under the Clean Air Act requires a differentiated approach:

> Greenhouse gas emissions from section 202(a) source categories, or from any other U.S. source, will become globally mixed in the atmosphere, and thus will have an effect not only on the U.S. regional climate but on the global climate as a whole, and indeed for years and decades to come. The Administrator believes that these unique, global aspects of the climate change problem tend to support a finding that lower levels of emissions should be considered to contribute to the air pollution than might otherwise be considered appropriate when considering contribution to a local or regional air pollution problem. [¶] *. . . If the U.S. and the rest of the world are to combat the risks associated with global climate change, contributors must do their part even if their contributions to the global*

[108] Clean Air Act § 110(2), 42 U.S.C. § 7410(2) (2008).
[109] U.S. Envtl. Prot. Agency, *supra note* 3; Pew Ctr. on Global Climate Change, *supra* note 3.
[110] 73 Fed. Reg. at 44481.

> *problem, measured in terms of percentage, are smaller than typically encountered when tackling solely regional or local environmental issues.*[111]

In other words, EPA now fully acknowledges that the U.S. must reduce its greenhouse gas emissions from all sources even though reduction in any individual state or in the U.S. alone will not achieve the full remediation of their deleterious impacts on public health and welfare.

Moreover, Section 179B of the Clean Air Act specifically contemplates and provides an answer to the problem of international emissions.[112] Section 179B states that a state implementation plan

> shall be approved by the Administrator [if the state] establishes to the satisfaction of the Administrator that the implementation plan of such State would be adequate to attain and maintain the relevant national ambient air quality standards by the attainment date . . . *but for* emissions emanating from outside of the United States.[113]

Because greenhouse gases are globally mixed, precisely this calculation must be performed by all nations in whatever attempt is made to reduce their own emissions so that a sustainable global greenhouse gas concentration level can be reached – whether through the Clean Air Act, a carbon tax, a cap-and-trade scheme, or some combination or other alternative. There is, therefore, no obstacle to the successful implementation of the statutory scheme. As long as each greenhouse gas state implementation plan accomplishes the state's proportional share of the greenhouse gas reductions necessary to achieve the national pollution cap, and otherwise complies with the requirements of section 110, EPA must approve the state implementation plan. If the plan does not meet these requirements, then EPA must design a federal implementation plan in order to do so. A state's proportionate share would be based on the emissions reductions necessary for the nation as a whole to contribute to global greenhouse gas reductions to below the established pollution limit. The allocation of a proportionate share to a state can be based on any reasonable allocation, such as on the types and numbers of emission sources within its boundaries, population numbers or some other reasonable metric or combination of metrics.

C. The Substantial Benefits of State Implementation Planning for Greenhouse Gases

The development of state implementation plans will have numerous regulatory and practical benefits, including allowing states to build upon existing programs, taking advantage of existing expertise and familiarity with the current regulatory structure, encouraging innovation, and providing consistency and coordination among state programs. Without federal involvement in the ongoing state efforts, their success rate and economic return will necessarily be diminished by the lack of a common pollution limit, lack of nationwide participation, overlapping and/or contradictory requirements, lack of collective learning and potential unnecessary duplication of effort. It is essential that EPA facilitate the state implementation planning process as

[111] 74 Fed. Reg. at 18907 (emphasis added).
[112] Clean Air Act § 179, 42 U.S.C. § 7509a (2008); Christopher T. Giovinazzo, *Defending Overstatement: The Symbolic Clean Air Act*, 30 HAR. ENV. L. REV. 99, 154-55 (2006).
[113] 42 U.S.C. § 7509a(a)(2) (2008) (emphasis added).

expeditiously as possible in order to realize these substantial benefits, a few of which are enumerated below.

First, many strategies that can best reduce greenhouse gas emissions will require policy actions in areas that have traditionally been regulated by states and municipalities, such as land use policies, building codes for residential, commercial and industrial facilities, transportation, utility regulation and agriculture regulation, forestry, and non-hazardous waste handling.[114] By influencing building codes, development patterns, efficiency requirements and land use policies, states are able to control the emissions from these types of projects. The state implementation plan process incorporates these critically important, but traditionally state-controlled areas of regulation into a unified greenhouse gas reduction structure for the nation. Studies performed to date indicate that such local measures can have a significant impact on GHG emissions in the United States.[115] Because greenhouse gases are emitted by numerous stationary and mobile sources, there is no silver bullet solution to the climate crisis; rather, EPA must implement reductions in a variety of contexts in a complementary fashion. The Clean Air Act is designed to do just that, and the importance of mobilizing all the states in their traditional areas of jurisdiction cannot be overemphasized.

Second, because state implementation plans can effectively address areas traditionally under state and local control, the state implementation plan process would fill the gaps in proposed federal emission trading strategies. While cap-and-trade strategies may address some aspects of the greenhouse gas problem, achieving emission reductions on a large enough scale and rapidly enough to prevent the most extreme manifestations of climate change will require substantial changes in behavior among many actors in all sectors of the economy that cap-and-trade strategies are unlikely to fully or effectively address.[116] Rather than rely solely on an untested emissions market, state and local planning strategies must also target areas, such as land use and building codes, for which trading schemes are not well suited.

Third, the significant strides states have already made in reducing their emissions are presently not integrated with federal action. Federal review of state climate reduction efforts

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[114] Doremus, *supra* note 6, at 827-28; Alice Kaswan, *A Cooperative Federalism Proposal for Climate Change Legislation: The Value of State Autonomy in a Federal System*, 95 DENV. U. L. REV. 791, 829 (2008). For example, one study found that residential and commercial buildings—structures that fit squarely within a state's jurisdiction—account for one-third of U.S. carbon emissions. MARILYN A. BROWN ET AL., BROOKINGS INST. METROPOLITAN POLICY PROGRAM, *Shrinking the Carbon Footprint of Metropolitan America* (May 2008), *available at* http://www.brookings.edu/reports/2008/05_carbon_footprint_sarzynski.aspx. Another study concluded that compact development patterns can reduce vehicle miles traveled, and the associated carbon emissions, by as much as 20 – 40%. REID EWING ET AL., GROWING COOLER: THE EVIDENCE ON URBAN DEVELOPMENT AND CLIMATE CHANGE 10-11 (2007), *available at* http://www.smartgrowthamerica.org/documents/growingcoolerCH1.pdf.

[115] As of 2007, almost half (23) of the states had joined one of three regional emission reduction programs that together account for about 39% of U.S. CO_2 emissions and pursue reduction targets. JONATHAN L. RAMSEUR, CONGRESSIONAL RESEARCH SERVICE, CLIMATE CHANGE: ACTION BY STATES TO ADDRESS GREENHOUSE GAS EMISSIONS 25 (2007), *available at* http://www.ncseonline.org/NLE/CRSreports/07Dec/RL33812.pdf. For example, a study has shown that compact residential and commercial development patterns can, by themselves, reduce total transportation-related CO_2 emissions by 7 to 10 percent in 2050. EWING ET AL., *supra* note 114, at 9. Residential and commercial buildings account for 21 and 18 percent, respectively, of CO2 emissions that can be reduced by local building codes. *Id.*

[116] Doremus, *supra* note 6, at 800.

though the state implementation plan process will ensure uniformity among states, address interstate leakage concerns by requiring all states to take action, and vertically integrate rapidly expanding state and local climate change programs, as well as international programs, into a comprehensive national program.[117]

Fourth, the autonomy given to the states and significant latitude to experiment with control methods and technologies through the state implementation plan process also encourages innovation.[118] As Justice Brandeis noted in 1932, states have greater flexibility that allows them to innovate with less severe consequences and use their ability to experiment to provide models for future federal legislation.[119] In addition to allowing states to experiment, the state implementation plan framework allows states to learn from each other's successes and failures, and provides opportunity for greater collaboration among states.[120]

Fifth, mandatory state planning also allows policy choices to respond to local variation in challenges and opportunities in a cost-effective manner. Each state has important differences in climate, resources, industry mix, transportation and legal structures for local government, public finance and utility regulation. Because of these differences among states, individualized consideration of the mix of greenhouse gas emission reduction measures, strategies and market and non-market approaches appropriate for each state will produce a more cost-effective approach than a single federal plan.[121]

Sixth, state emission reduction plans for greenhouse gases are extremely cost-effective and can result in significant economic benefits, even beyond those obtained through regulation of traditional air pollutants. Not only do greenhouse gas reduction measures result in economic benefits through avoidance of climate change damages, but the many measures targeting energy efficiency and reduced reliance on fossil fuels result in substantial savings over time.[122] Recent state climate action plans demonstrate net economic savings from combined effects of specific, tried and tested action at the state level when combined with long-term transitions toward new technologies, systems and practices.[123] In a preliminary analysis based on data from 20 states with completed climate action plans, the Center for Climate Strategies estimated that "the U.S. could reduce GHG emissions to 10% below 1990 levels by 2020 at an estimated net economic savings of $20.8 billion in 2012 and $85 billion in 2020, from 2009 to 2020 cumulative savings of $535.5 billion, through implementing a climate plan involving all U.S. states and economic

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[117] *See* Thomas D. Peterson et al., *Developing a Comprehensive Approach to Climate Change Policy in the United States that Fully Integrates Levels of Government and Economic Sectors*, 26 VIR. ENV. L. J. 227, 229, 264 (2008).
[118] Kaswan, *supra* note 114, at 800.
[119] *New State Ice Co. v. Liebmann*, 285 U.S. 262 (1932) (Brandeis, J., dissenting).
[120] Doremus, *supra* note 6, at 829.
[121] Robert McKinstry et al., *The New Climate World: Achieving Economic Efficiency in a Federal System for GHG Regulation Through State Planning Combined with Federal Programs*, 34 N.C.J. INT'L L. & COM. REG. 767, 777 (2009).
[122] *See, e.g.*, CALIFORNIA AIR RESOURCES BOARD, CLIMATE CHANGE SCOPING PLAN 73 (Dec. 2008), *available at* http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf.
[123] Peterson et al., *supra* note 117, at 250-51.; *see also* CALIFORNIA AIR RESOURCES BOARD, *supra* note 122, at 73-97 (economic evaluation of greenhouse gas scoping plan).

sectors."[124] The savings estimate did not include the potential for additional co-benefits such as energy independence and health and environmental protection.[125]

Finally, additional benefits of the Clean Air Act and the state implementation plan process include the minimization of pollution havens and establishing greater incentives for pollution control research and development than individual state or local rules could provide.[126] The Act has long promoted health and environmental research, as well as technology transfer and other information management and dissemination services, and has resulted in the provision of substantial financial resources to state and local government programs and many other services.[127] The Clean Air Act has been responsible for controlling some of our most seemingly intractable air pollution problems, including the regional fine particle pollution which is responsible for much of the estimated monetary benefit of historical air pollution control;[128] these same successful strategies must be put to work reducing greenhouse gas pollution.

The national pollution limit and state implementation planning program is one of the primary mechanisms by which the Clean Air Act combines the best of both state and federal involvement to create a coherent and comprehensive program for the most effective regulation of greenhouse gases. The cooperative federalism structure already embodied in this modern law is ideally suited to achieving the required greenhouse gas reductions from all sectors of the economy.

TIMELINE FOR PETITIONED ACTIONS

The Clean Air Act includes mandatory deadlines for the petitioned actions (e.g., issuance of national pollution caps) and actions which consequently become required (e.g., preparation and submission of state implementation plans). Based on the urgency of the climate crisis, Petitioners believe the EPA and the states can and must act far faster than the maximum time allowed by statute. Table 3 sets forth both the statutory deadlines and the petitioned timeline for some of the key petitioned and consequent actions.

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[124] CENTER FOR CLIMATE STRATEGIES, CLIMATE CHANGE POLICY AS ECONOMIC STIMULUS: EVIDENCE AND OPPORTUNITIES FROM THE STATES 4 (2008), *available at* http://www.climatestrategies.us/ewebeditpro/items/O25F20494.pdf.
[125] *Id.*
[126] U.S. ENVTL. PROT. AGENCY, *supra* note 9, at 3.
[127] *Id.*
[128] *Id.*

Table 3: Timeline for Petitioned and Consequent Actions

Petitioned or Consequent Action	Maximum Time Allowed by Statute	Action Requested Within (Time from Present)
Designate the greenhouse gases as criteria air pollutants	EPA must respond to the petition within a reasonable time	6 months
Issue air quality criteria and information on air pollution control techniques for the greenhouse gases pursuant to section 108(a)(2) and (b)(1)	12 months from criteria air pollutant designation	9 months
Publish proposed national primary and secondary pollution caps for the greenhouse gases pursuant to section 109(a)	12 months from criteria air pollutant designation	9 months
Publish final national primary and secondary pollution caps for the greenhouse gases	No later than 90 days after initial publication of proposed caps	1 year
States submit state implementation plan revisions incorporating measures for greenhouse gases to EPA pursuant to section 110(a)	3 years (or "such shorter period as the Administrator may prescribe") from promulgation of final pollution caps	2 years
EPA find the plans complete or requires revision	Within 60 days of receipt of plan	2 years, 2 months
Full or partial approval of state plans, begin full implementation	Within 12 months of finding a plan complete	2 ½ years

Petitioners recognize that the petitioned timeline is faster in many regards than past compliance for current criteria air pollutants. Petitioners further recognize that some may argue that establishment of a national pollution limit for greenhouse gases and full deployment of the state implementation planning process will take too long, based in part on lengthy delays in past implementation. Petitioners, however, reject any cynical assertion that the EPA and states cannot be expected to meet the timelines set forth in the law. Moreover, to the degree that some may argue that further delays in implementation are inevitable due to industry lawsuits, or that the system would be too complicated or unworkable, those arguments could all be made with greater strength with regard to the currently proposed cap-and-trade program in federal climate legislation. It is, in fact, more likely that an entirely new greenhouse regulatory scheme will be subject to delay due to lawsuits from industry, as opposed to implementation of the Clean Air Act, under which the EPA, states, and industry have four decades of experience.

CONCLUSION

The EPA's delay to date in implementing greenhouse gas regulation pursuant to the Clean Air Act not only jeopardizes public health and welfare, but has taken us almost to a point of no return that may change our planet's future in profound and tragic ways. For all the reasons discussed above, we urge the EPA to quickly implement the steps described in this petition.

As leading climate scientists note, "[r]ealization that we must reduce the current CO_2 amount has a bright side: effects that had begun to seem inevitable, including impacts of ocean acidification, loss of fresh water supplies, and shifting of climatic zones, may be averted by the necessity of finding an energy course beyond fossil fuels sooner than would otherwise have occurred."[129]

These authors conclude

> [w]ith simultaneous policies to reduce non-CO_2 greenhouse gases, it appears still feasible to avert catastrophic climate change. Present policies, with continued construction of coal fired power plants without CO_2 capture, suggest that decision-makers do not appreciate the gravity of the situation. We must begin to move now toward the era beyond fossil fuels. Continued growth of greenhouse gas emissions, for just another decade, practically eliminates the possibility of near-term return of atmospheric composition beneath the tipping level for catastrophic effects. The most difficult task, phase-out over the next 20-25 years of coal use that does not capture CO_2, is Herculean, yet feasible when compared with the efforts that went into World War II. The stakes, for all life on the planet, surpass those of any previous crisis. The greatest danger is continued ignorance and denial, which could make tragic consequences unavoidable.[130]

We urge the EPA to rapidly and fully utilize the tools provided by the Clean Air Act—tools that for many years have proven both successful and cost-effective—to address the climate crisis as detailed in this petition.

Respectfully Submitted this 2nd day of December, 2009.

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[129] Hansen, *supra* note 70, at 228.
[130] *Id.* at 229.

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APPENDIX A: PETITIONED POLLUTANTS

Table 4: Petitioned Pollutants (data from P. Forster et al., *Changes in Atmospheric Constituents and in Radiative Forcing, in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (Solomon, S., et al. eds., Cambridge University Press 2007).

Pollutant	Atmospheric Lifetime (years)	GWP1 20-yr	GWP 100-yr	GWP 500-yr
Carbon Dioxide (CO_2)	*	1	1	1
Methane (CH_4)	12	72	25	7.6
Nitrous Oxide (N_2O)	114	289	298	153
Hydrofluorocarbons (HFCs)	1.4-270			
HFC-23	270	12000	14,800	12,200
HFC-32	4.9	2,330	675	205
HFC-125	29	6350	3,500	1,100
HFC-134a	14	3830	1,430	435
HFC-143a	52	3,800	5,890	4,470
HFC-152a	1.4	437	124	38
HFC-227ea	34.2	5,310	3,220	1,040
HFC-236fa	240	8,100	9,810	7,660
HFC-245fa	7.6	3,380	1,030	314
HFC-365mfc	8.6	2,520	794	241
HFC-43-10mee	15.9	4,140	1,640	500
Perfluorocarbons (PFCs)				
PFC-14	50,000	5210	7,390	11,200
PFC-116	10,000	8630	12,200	18,200
PFC-218	2,600	6,130	8,830	12,500
PFC-318	3,200	7,310	10,300	14,700

PFC-3-1-10	2,600	6,330	8,860	12,500
PFC-4-1-12	4,100	6,510	9,160	13,300
PFC-5-1-14	3,200	6,600	9,300	13,300
PFC-9-1-18	>1000	>5,500	>7,500	>9,500
Trifluoromethyl Sulphur Petafluoride	800	13,200	17,700	21,200
Sulfur hexafluoride (SF_6)	3,200	16300	22,800	32,600
Nitrogen trifluoride	740	12300	17,200	20,700

EPA-2602

William Perkins/DC/USEPA/US
12/02/2009 12:04 PM

To Erin Birgfeld, Rona Birnbaum, Lesley Jantarasami, Stacy Kika
cc
bcc
Subject Endangerment timeline for OPA

All,

Thank you for your excellent input on the timeline. Here is what I came up with based upon everyone's comments (a couple of slight tweaks from the last track changes version that went around). If you feel that something should be changed, please let me know before 1:00 p.m.; at that time I will send it our contractor to graphically format it for us this afternoon. Thank you.

Cheers,

Bill

(b)(5) Deliberative

Endangerment Timeline 120209.doc

Bill Perkins
Climate Change Adaptation Analyst
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perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

EPA-2603

David Chalmers/DC/USEPA/US
12/02/2009 12:10 PM

To William Perkins
cc
bcc
Subject Fw: vulnerable pop, EJ, and public health

I'll call in a second.

----- Forwarded by David Chalmers/DC/USEPA/US on 12/02/2009 12:09 PM -----

From: David Chalmers/DC/USEPA/US
To: Jeremy Martinich/DC/USEPA/US@EPA
Date: 12/02/2009 11:45 AM
Subject: Fw: vulnerable pop, EJ, and public health

Please be aware of the section highlighted below I saw while quickly scanning through this. I could look for one such example, or it might be better and easier to just end the sentence after TSD.

Thanks,

David Chalmers
ORISE Fellow
U.S. EPA, Climate Change Division
202.343.9814

----- Forwarded by David Chalmers/DC/USEPA/US on 12/02/2009 11:38 AM -----

From: Michael Kolian/DC/USEPA/US
To: William Perkins/DC/USEPA/US@EPA, Jason Samenow/DC/USEPA/US@EPA, David Chalmers/DC/USEPA/US@EPA
Cc: Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 11:36 AM
Subject: vulnerable pop, EJ, and public health

I think we may want to [redacted] (b)(5) Deliberative [redacted]

1) We may want to consider seeing how we can highlight these issues in the General Section of volume 5 and referring to volume 8 (which may not due very much) and noting the overlap.

2) I think this is a great response in vol 8 which we should highlight up front somewhere with additional examples.

Jason, what's the path forward for continuing to revise parts of vol 5? I don't think shoring up this relationship will require that much work.....

Comment (8-xx):
[redacted] (b)(5) Deliberative [redacted]

(b)(5) Deliberative

[redacted]

Response (8-xx):

(b)(5) Deliberative

[redacted]

EPA-2604

Suzanne Kocchi/DC/USEPA/US
12/02/2009 12:11 PM

To Carol Holmes
cc Ben DeAngelo, Dina Kruger, John Hannon, Rona Birnbaum, Erin Birgfeld
bcc
Subject Re: Plan for clearance - PRESS STUFF

I think Heidi just wanted the public press stuff and only before we release it, not before clearance. Erin is checking [redacted] (b)(5) Deliberative so I will leave all coordination to her.

Carol Holmes By midnight Monday, your mean 12:01... 12/02/2009 11:05:12 AM

From: Carol Holmes/DC/USEPA/US
To: Suzanne Kocchi/DC/USEPA/US
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 11:05 AM
Subject: Re: Plan for clearance

By midnight Monday, your mean 12:01am Monday morning, right?

Also, which press materials? Just press release and fact sheet (public info) or all the internal stuff? If the latter John or I will want to review them first, so we'd need to do that by tomorrow?

Given above, should I do preamble before V4? Sounds like it.....please send me latest.

Confidential communication for internal deliberations only; Attorney-client, attorney work product and/or enforcement privilege; Do not distribute outside EPA or DOJ

Carol S. Holmes
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW (MC 2344A)
Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Suzanne Kocchi Just talked to Heidi: 1) She would like... 12/02/2009 10:59:43 AM

From: Suzanne Kocchi/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA
Date: 12/02/2009 10:59 AM
Subject: Plan for clearance

Just talked to Heidi:

1) She would like a redline [redacted] (b)(5) Deliberative

2) Once she gives us the ok, we will have OPEI upload a clean version of the preamble and TSD to ROCIS. She said it is fine to do this Fri morning. If there are any further edits we made between the track

changes version and the clean version we should highlight for her. As soon as she gets it from OPEI in ROCIS she will initiate clearance there on Fri.

3) She is double checking (b)(5) Deliberative

4) She would like to see a copy of all press materials - (b)(5) Deliberative

I think this means we need to have pens down on the preamble no later than 2 pm tomorrow so we can give Heidi time to review the redline and talk with us about anything she is concerned about.

EPA-2605

Rona Birnbaum/DC/USEPA/US
12/02/2009 12:12 PM

To William Perkins
cc Erin Birgfeld, Lesley Jantarasami, Stacy Kika
bcc
Subject Re: Endangerment timeline for OPA

looks good to me. suggest you send it on as soon as possible so that we can give formatted version to Dina to have a quick look at later this afternoon.

Rona Birnbaum
Chief, Climate Science and Impacts Branch
USEPA, Climate Change Division
birnbaum.rona@epa.gov
202-343-9076

William Perkins All, Thank you for your excellent input o... 12/02/2009 12:04:52 PM

From: William Perkins/DC/USEPA/US
To: Erin Birgfeld/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Lesley Jantarasami/DC/USEPA/US@EPA, Stacy Kika/DC/USEPA/US@EPA
Date: 12/02/2009 12:04 PM
Subject: Endangerment timeline for OPA

All,

Thank you for your excellent input on the timeline. Here is what I came up with based upon everyone's comments (a couple of slight tweaks from the last track changes version that went around). If you feel that something should be changed, please let me know before 1:00 p.m.; at that time I will send it our contractor to graphically format it for us this afternoon. Thank you.

Cheers,

Bill

[attachment "Endangerment Timeline 120209.doc" deleted by Rona Birnbaum/DC/USEPA/US]

Bill Perkins
Climate Change Adaptation Analyst
Climate Science and Impacts Branch
Climate Change Division
U.S. Environmental Protection Agency
perkins.william@epa.gov
(O) 202.343.9460
(F) 202.343.2202
(C) (b)(6)

EPA-2606

Suzanne Kocchi/DC/USEPA/US
12/02/2009 12:18 PM

To John Hannon
cc Ben DeAngelo, Carol Holmes, Dina Kruger, Rona Birnbaum
bcc
Subject Re: Plan for clearance -- latest version of Findings

That's fine too. The main thing at this point is getting it to a paragraph on page 1. If there is any text that is currently there that we would like to preserve we can move it to I, otherwise, let's delete.

John Hannon We should; consider not adding more t... 12/02/2009 12:17:15 PM

From: John Hannon/DC/USEPA/US
To: Suzanne Kocchi/DC/USEPA/US@EPA
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Carol Holmes/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 12:17 PM
Subject: Re: Plan for clearance -- latest version of Findings

We should; consider not adding more text to the Overview in I. The Summary is long (b)(5) Deliberative [redacted] So we can consider just shortening it, unless there is something we need to add to I.

John Hannon
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW (MC 2344A)
Washington, D.C. 20460
Phone (202) 564-5563
Fax (202 564-5603

Suzanne Kocchi All - Jeremy just heard from Vickie Re... 12/02/2009 12:04:28 PM

From: Suzanne Kocchi/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 12:04 PM
Subject: Re: Plan for clearance -- latest version of Findings

All - Jeremy just heard from Vickie Reed that per FR requirements the summary on page 1 needs to be shortened considerably. Rona, Jeremy and I just chatted. Probably best thing to do is 1) come up with a 1 paragraph summary for the summary section, 2) shift the text that is currently in the summary to I. Introduction before the Overview and 3) Rename the Overview something like "Introduction.

We can do this tomorrow unless Carol and/or Ben want to take a stab.

For now, Carol has the pen.

Ben DeAngelo Here's the latest version of the Findings... 12/02/2009 11:59:35 AM

From: Ben DeAngelo/DC/USEPA/US
To: Carol Holmes/DC/USEPA/US@EPA
Cc: Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA

Date: 12/02/2009 11:59 AM
Subject: Re: Plan for clearance -- latest version of Findings

Here's the latest version of the Findings.

I inserted in here Gina's comments. She flagged a number of sentences where she (b)(5) Deliberative [redacted]

I will need this back one more time before tomorrow afternoon to finish some misc items.

Pay close attention to ERG's edits. We're using "United States" as noun and "U.S." as adjective. I thought we wanted to use "Findings" not this "preamble".

[attachment "Endangerment Findings Master_track changes _120209am_jh+sk+bd.doc" deleted by John Hannon/DC/USEPA/US]

Carol Holmes By midnight Monday, your mean 12:01... 12/02/2009 11:05:12 AM

From: Carol Holmes/DC/USEPA/US
To: Suzanne Kocchi/DC/USEPA/US
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 11:05 AM
Subject: Re: Plan for clearance

By midnight Monday, your mean 12:01am Monday morning, right?

Also, which press materials? Just press release and fact sheet (public info) or all the internal stuff? If the latter John or I will want to review them first, so we'd need to do that by tomorrow?

Given above, should I do preamble before V4? Sounds like it.....please send me latest.

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Carol S. Holmes
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW (MC 2344A)
Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Suzanne Kocchi Just talked to Heidi: 1) She would like... 12/02/2009 10:59:43 AM

From: Suzanne Kocchi/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA
Date: 12/02/2009 10:59 AM
Subject: Plan for clearance

Just talked to Heidi:

1) She would like a redline (b)(5) Deliberative [redacted]

(b)(5) Deliberative

2) Once she gives us the ok, we will have OPEI upload a clean version of the preamble and TSD to ROCIS. She said it is fine to do this Fri morning. If there are any further edits we made between the track changes version and the clean version we should highlight for her. As soon as she gets it from OPEI in ROCIS she will initiate clearance there on Fri.

3) She is double checking (b)(5) Deliberative

4) She would like to see a copy of all press materials - (b)(5) Deliberative

I think this means we need to have pens down on the preamble no later than 2 pm tomorrow so we can give Heidi time to review the redline and talk with us about anything she is concerned about.

EPA-2607

Rona Birnbaum/DC/USEPA/US
12/02/2009 12:18 PM

To Jeremy Martinich
cc
bcc
Subject Fw: Plan for clearance -- latest version of Findings

ses latest attached. need to sir down with you to ensure that all places in final section where is highlighted and waiting for us is complete. Need to do this afternoon. What time can we meet?

----- Forwarded by Rona Birnbaum/DC/USEPA/US on 12/02/2009 12:18 PM -----

From: Suzanne Kocchi/DC/USEPA/US
To: Ben DeAngelo/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 12:04 PM
Subject: Re: Plan for clearance -- latest version of Findings

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Ben DeAngelo Here's the latest version of the Findings... 12/02/2009 11:59:35 AM

From: Ben DeAngelo/DC/USEPA/US
To: Carol Holmes/DC/USEPA/US@EPA
Cc: Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA, Suzanne Kocchi/DC/USEPA/US@EPA
Date: 12/02/2009 11:59 AM
Subject: Re: Plan for clearance -- latest version of Findings

Here's the latest version of the Findings.

I inserted in here Gina's comments. She flagged a number of sentences where she (b)(5) Deliberative [redacted]

I will need this back one more time before tomorrow afternoon to finish some misc items.

Pay close attention to ERG's edits. We're using "United States" as noun and "U.S." as adjective. I thought we wanted to use "Findings" not this "preamble".

(b)(5) Del berative [redacted]
Endangerment Findings Master_track changes _120209am_jh+sk+bd.doc

Carol Holmes By midnight Monday, your mean 12:01... 12/02/2009 11:05:12 AM

From: Carol Holmes/DC/USEPA/US
To: Suzanne Kocchi/DC/USEPA/US
Cc: Ben DeAngelo/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA, Rona Birnbaum/DC/USEPA/US@EPA
Date: 12/02/2009 11:05 AM
Subject: Re: Plan for clearance

By midnight Monday, your mean 12:01am Monday morning, right?

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Carol S. Holmes
Office of General Counsel
U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW (MC 2344A)
Washington, DC 20460
Phone (202) 564-8709
Fax (202) 564-5603

Suzanne Kocchi Just talked to Heidi: 1) She would like... 12/02/2009 10:59:43 AM

From: Suzanne Kocchi/DC/USEPA/US
To: Rona Birnbaum/DC/USEPA/US@EPA, Dina Kruger/DC/USEPA/US@EPA, Ben DeAngelo/DC/USEPA/US@EPA
Cc: Carol Holmes/DC/USEPA/US@EPA, John Hannon/DC/USEPA/US@EPA
Date: 12/02/2009 10:59 AM
Subject: Plan for clearance

Just talked to Heidi:

1) She would like a redline [redacted] (b)(5) Deliberative [redacted]

2) Once she gives us the ok, we will have OPEI upload a clean version of the preamble and TSD to ROCIS. She said it is fine to do this Fri morning. If there are any further edits we made between the track changes version and the clean version we should highlight for her. As soon as she gets it from OPEI in ROCIS she will initiate clearance there on Fri.

3) She is double checking [redacted] (b)(5) Deliberative [redacted]

4) She would like to see a copy of all press materials - [redacted] (b)(5) Deliberative [redacted]

I think this means we need to have pens down on the preamble no later than 2 pm tomorrow so we can give Heidi time to review the redline and talk with us about anything she is concerned about.

EPA-2608

"Matthew Mitchell" <Matthew.Mitchell@erg.com>
12/02/2009 12:20 PM

To Lesley Jantarasami, William Perkins, "Mae Thomas", "Sue Eisenfeld"
cc
bcc
Subject Fwd: Volume 5

The file's attached to this email. Sorry about that!

Matthew N. Mitchell
ERG
110 Hartwell Avenue
Lexington, MA 02421-3136
(p) 781-674-7331
(f) 78
(b)(5) Deliberative

RTC Vol 5 120109 mm jt.doc

----- Message from "Matthew Mitchell" <Matthew.Mitchell@erg.com> on Wed, 02 Dec 2009 12:19:11 -0500 -----

To: <Jantarasami.Lesley@epamail.epa.gov>
cc: <Perkins.William@epamail.epa.gov>, "Mae Thomas" <Mae.Thomas@erg.com>, "Sue Eisenfeld" <Sue.Eisenfeld@erg.com>
Subject: Volume 5

Hi Lesley and Bill--

Thanks very much for the info!

I'm attaching Volume 5, including the reference list. (Note that we used the same color-coding as last time on those references: red highlights for missing references, green highlights for references we inserted that we're confident about, etc.)

Please let me know if you have any questions.

Matthew N. Mitchell
ERG
110 Hartwell Avenue
Lexington, MA 02421-3136
(p) 781-674-7331
(f) 781-674-2851
>>> <Jantarasami.Lesley@epamail.epa.gov> 12/02/09 11:22 AM >>>
Hi Matt,

They will both be around 40 pages.

Thanks,

Lesley

Lesley Jantarasami
US EPA, Climate Change Division
Climate Science & Impacts Branch
202.343.9929

202.343.2202 (fax)
Jantarasami.Lesley@epa.gov

|------------>
| From: |
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>--
--|
|"Matthew Mitchell" <Matthew.Mitchell@erg.com>
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|------------>
| To: |
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--|
|William Perkins/DC/USEPA/US@EPA, "Sue Eisenfeld" <Sue.Eisenfeld@erg.com>
|

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|------------>
| Cc: |
|------------>

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|Lesley Jantarasami/DC/USEPA/US@EPA, "Mae Thomas" <Mae.Thomas@erg.com>
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|------------>
| Date: |
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|12/02/2009 11:18 AM
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|------------>
| Subject: |
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|lengths of remaining volumes?
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Hi Bill and Lesley--

I'm not sure this information is readily available, but in case it is: any sense of how long Volumes 6 and 9 are going to be? At present we're expecting Volume 9 today (and Volume 6 too, maybe?), so I'm trying to get a sense of what we should expect page-count-wise.

Hope all is well. I'm putting the finishing touches on Volume 5 right now.

Matthew N. Mitchell
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Lexington, MA 02421-3136
(p) 781-674-7331
(f) 781-674-2851

EPA-2609

Lesley Jantarasami/DC/USEPA/US
12/02/2009 12:22 PM

To Mike Kolian
cc
bcc
Subject latest forestry section

Mike,

My revisions to forestry are attached. The drought comment from my previous email is on page 12. If you find a forestry comment that goes with it, I think it should be it's own separate comment/response because the other comment is all about wildfire attribution. There are still many unresolved questions in here, so see what you can do with it and then we should circle back with Ben this afternoon. Sound good?

Lesley

(b)(5) Deliberative

RTC_draft_Volume_6_Forestry_only 120109 BJD MK LJ.doc

Lesley Jantarasami
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Climate Science & Impacts Branch
202.343.9929
202.343.2202 (fax)
Jantarasami.Lesley@epa.gov

EPA-2610

Michael Kolian/DC/USEPA/US
12/02/2009 12:33 PM

To Lesley Jantarasami
cc
bcc
Subject Re: vol 6 question

It comes from 3596.2 Michaels. It is under the discussion of Climate Variability and Extreme Events for **drought** frequency.
The commenter mentions McCabe et al. 2004, Zhang, 2007, 2008; and Seager et al., 2008 (attached).

I agree (b)(5) Deliberative Note Seager only discusses the Southeast. The others primarily address the SW.

roz0801_Zhang 2008.pdf 4136.full mcCabe_2004.pdf Westerling_2006.pdf 26020326 sohngen_2001.pdf
Seager_etal_SE_2009.pdf

Lesley Jantarasami Mike, This reference (b)(5) Deliberative 12/02/2009 12:10:36 PM

From: Lesley Jantarasami/DC/USEPA/US
To: Mike Kolian <kolian.michael@epa.gov>
Date: 12/02/2009 12:10 PM
Subject: vol 6 question

Mike,

This reference (b)(5) Deliberative

Thanks,

Lesley

Comment:
(b)(5) Deliberative

Drought in the Southeastern United States: Causes, Variability over the Last Millennium, and the Potential for Future Hydroclimate Change*

RICHARD SEAGER

Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York

ALEXANDRINA TZANOVA

Columbia College, Columbia University, New York, New York

JENNIFER NAKAMURA

Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York

(Manuscript received 16 June 2008, in final form 14 April 2009)

ABSTRACT

An assessment of the nature and causes of drought in the southeastern United States is conducted as well as an assessment of model projections of anthropogenically forced hydroclimate change in this region. The study uses observations of precipitation, model simulations forced by historical SSTs from 1856 to 2007, tree-ring records of moisture availability over the last millennium, and climate change projections conducted for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. From the perspective of the historical record, the recent drought that began in winter 2005/06 was a typical event in terms of amplitude and duration. Observations and model simulations are used to show that dry winter half-years in the Southeast are weakly associated with La Niñas in the tropical Pacific but that this link varies over time and was possibly of opposite sign from about 1922 to 1950. Summer-season precipitation variability in the Southeast appears governed by purely internal atmospheric variability. As such, model simulations forced by historical SSTs have very limited skill in reproducing the instrumental record of Southeast precipitation variability and actual predictive skill is also presumably low. Tree-ring records show that the twentieth century has been moist from the perspective of the last millennium and free of long and severe droughts that were abundant in previous centuries. The tree-ring records show a 21-yr-long uninterrupted drought in the mid-sixteenth century, a long period of dry conditions in the early to mid-nineteenth century, and that the Southeast was also affected by some of the medieval megadroughts centered in western North America. Climate model projections predict that in the near term, future precipitation in the Southeast will increase but that evaporation will also increase. The median of the projections predicts a modest reduction in the atmospheric supply of water vapor to the region; however, the multimodel ensemble exhibits considerable variation, with a quarter to a third of the models projecting an increase in precipitation minus evaporation. The recent drought, forced by reduced precipitation and with reduced evaporation, has no signature of model-projected anthropogenic climate change.

1. Introduction

Perceptions of drought in North America normally focus on the arid and semiarid lands of the Great Plains and Canadian Prairies, the interior West, the Southwest, and Mexico. It might be thought that this focus is a consequence of the dryness of these regions: precipitation reductions of equal magnitude will create larger effects on water resources in dry regions than in the more humid regions of the Northwest, Southeast, and Northeast. But there is more to it than that. Herweijer et al. (2007) used millennium-long tree-ring reconstructions of summer Palmer drought severity index (PDSI) over North America to show that, in the semiarid interior, decadal and longer time-scale variability explains a majority of the total variance compared to

* Lamont-Doherty Earth Observatory Contribution Number 7294.

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E-mail: seager@ldeo.columbia.edu

DOI: 10.1175/2009JCLI2683.1

seasonal to interannual variability in the coastal regions. This spatial distribution closely matches the distribution of total precipitation and implies that the wet coastal regions, although experiencing large interannual variability, are not prone to the persistent multiyear droughts that plague the interior West and Great Plains.

Consistent with this, the great droughts of North America—including the Dust Bowl of the 1930s, the 1890s drought, the Southwest drought of the 1950s, and the post-1998 "turn of the century" drought—have all been centered in the central to western parts of the interior United States (Fye et al. 2003, 2004; Cook et al. 2004; McCabe et al. 2004; Schubert et al. 2004a,b; Seager et al. 2005b; Herweijer et al. 2006; Cook et al. 2007; Seager 2007). Furthermore, the multidecadal droughts that made up the medieval period of elevated aridity (Cook et al. 2004) were also centered in the interior West of North America (Herweijer et al. 2007). However, even though the eastern parts of the United States do not, in general, experience multiyear intense droughts, short periods of a year to a few years do occur when precipitation reductions place serious stresses on water resources. A striking example of such an event is the recent drought that began in winter 2005/06 in the southeastern United States. This drought extended at most two years—brief by Western standards—but has led to more than a billion dollars in crop losses and has placed massive strain on the water supply system of the affected states, pitting state against state and user against user, as all those affected attempt to avoid a drop off in available water (Manuel 2008).

At the root of the water supply problem in the Southeast is a growing population, driven in large part by in-migration, over the last few decades. For example, Georgia's population grew from 6 478 216 in 1990 to 8 186 453 in 2000 and an estimated 9 544 750 in 2007, according to U.S. census figures (available online at http://www.census.gov)—that is an almost 50% increase in just 17 yr. Almost a quarter of total water use in Georgia, for example, is for public water supply (available online at http://ga.water.usgs.gov/projects/projectwateruse.html) and thus these population increases have placed notable stress on the available water resources.

The recent southeastern drought brings up several important questions that we attempt to answer here.

- How does the precipitation reduction that caused the recent drought compare with prior events in the instrumental record?
- What are the causes of drought in the Southeast? Is drought in this region caused by anomalies of sea surface temperatures (SSTs) (as in the West) or by random atmospheric variability?
- How well do climate models simulate hydroclimate variability in the Southeast? Is there potential for predicting hydroclimate variability in this region using predictions of SSTs?
- How do Southeastern droughts in the instrumental record compare to droughts over the last millennium inferred from tree-ring records? Have worse droughts occurred in more distant centuries?
- Is the recent drought in any way linked to anthropogenic climate change, and how is hydroclimate in the Southeast projected to change in the coming years to decades?

We will attempt to answer these questions using station and satellite measurements of precipitation in the region, observations of SST and sea level pressure (SLP), atmospheric model simulations of the 1856–2007 period forced by observed SSTs, atmospheric reanalyses and coupled atmosphere–ocean simulations of twentieth-century climate, and projections of current-century climate together with the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4). Examining such disparate data and model simulations necessarily requires a certain disjuncture in the metrics for drought and in the methods used. Analysis of the modern period will focus on the relation of drought to patterns of SST variability as a means of examining causes and predictability. We do not have SST records for the preinstrumental period, and the analysis will be more descriptive in nature. In addition, although variability continues in model projections of future hydroclimate change, there is also a trend toward increases in both precipitation and evaporation over the Southeast and that will be focused upon in this paper.

The tree-ring data used are reconstructions of the PDSI (Palmer 1965), but we choose not to convert the instrumental and model data to PDSI. PDSI has well-known problems (Alley 1984; Karl 1986; van der Schrier et al. 2006), but we are particularly concerned by whether its simple computation of evapotranspiration is reliable as climate change increases evaporative demand but not necessarily the net surface radiation that provides the energy for evapotranspiration (Burke et al. 2006). Alterations to the PDSI that specify the net radiation yield more reasonable results within models, but they cannot be widely applied to observations because of the lack of radiation data (Burke et al. 2006). In this situation a uniform approach to current, past, and future hydroclimate variability and change is not possible. Hence, although we have no choice but to examine PDSI reconstructions in regard to the tree-ring data, for the instrumental period and the future our analysis focuses on precipitation and therefore on meteorological drought

(AMS Council 1997; Heim 2002). Precipitation data is readily available and unambiguous, and droughts always involve reductions in precipitation (AMS Council 1997). Further, a focus on precipitation data allows us to make extensive use of satellite data with global coverage to examine the large-scale atmosphere–ocean context of drought in the Southeast. In a study of U.S. hydroclimate, Karnauskas et al. (2008) showed that at the regional scale, instrumental PDSI and precipitation track closely and "most differences are minor"; however, they also point out that PDSI can be notably affected by evaporation, which we accept. Although not resorting to PDSI, we will show that increased evapotranspiration is an important component of future projected climate change.

We will conclude that the recent drought was quite typical of historical droughts, that winter drought in the Southeast is weakly linked to a cold tropical Pacific Ocean, that summer drought is caused largely by internal atmospheric variability and, therefore, that there is limited predictability of extended droughts. We will also show that earlier centuries had droughts as severe as the recent one but which extended for as long as a decade or more. It will also be shown that the recent drought is unlikely to have been influenced by anthropogenic climate change but that the latter will lead to increased precipitation and also increased evapotranspiration with the potential for reduced soil moisture and river flow that would place further stress on regional water resources.

2. Data and models

a. *Observational data, reanalyses, and proxy reconstructions*

The precipitation data used here is the U.S. Climate Division data that extends from 1895 to the present. This consists of station data that have been binned into monthly values for each climate division. The climate divisions vary in size across the nation and are not of regular shape; however, in the Southeast they are typically about a degree in longitude and latitude. We also use the 1979 to present estimate of precipitation derived from gauges and satellites from the Global Precipitation Climatology Project (GPCP; Huffman et al. 1997). For SST we use the same data used to force the atmosphere model, as described below. This data consists of the Kaplan et al. (1998) data within the tropical Pacific (between 20°N and 20°S) and the Hadley Centre data from Rayner et al. (2003) outside of the tropical Pacific. The Hadley data begin in 1871, whereas the Kaplan data begin in 1856. Therefore, for 1856–70 outside of the tropical Pacific, we use Kaplan data where available and climatological SST in places where the Kaplan dataset does not report an actual value. This method provides for a continuous record of tropical Pacific SSTs from a single dataset for the entire 1856–2007 period. For sea level pressure, we use the Hadley Centre data of Allan and Ansell (2006). For limited purposes we also use the National Centers for Environmental Prediction–National Center for Atmospheric Research (NCEP–NCAR) reanalysis dataset (Kistler et al. 2001) and results from the Variable Infiltration Capacity (VIC) surface hydrology model forced by meteorological observations, as described by Liang et al. (1994) and Andreadis and Lettenmaier (2006).[1]

For a long-term perspective, we use an updated version (v2a; E. R. Cook, 2007 personal communication; available online at http://ingrid.ldgo.columbia.edu/expert/home/.jennie/.PDSI/.NADAv2a/pdsi/) of the North American Drought Atlas (NADA) of Cook and Krusic (2004). This is a gridded dataset of summer-season PDSI constructed from tree-ring records across Canada, the United States, and northern Mexico. The update uses more tree-ring records than in the initial release but uses the same statistical methods. The NADA data are described in Cook et al. (2004, 2007). Here we analyze the period from A.D. 1000 to 2006.

b. *Atmospheric simulations forced by observed historical SSTs*

The atmosphere model used here is the NCAR Community Climate Model, version 3 (CCM3) run at T42 resolution with 18 vertical levels (Kiehl et al. 1998). The simulations used here are updates to September 2007 of large ensembles of the post-1856 period that we have used extensively in previous studies of medieval-, nineteenth-, twentieth-, and current-century North American droughts (Seager et al. 2005b; Herweijer et al. 2006; Cook et al. 2007; Seager 2007; Seager et al. 2008b,a, 2009). The model simulations variously impose SST forcing globally or in individual ocean basins, a methodology introduced by Lau and Nath (1994), are as follows:

1. A 16-member ensemble from 1856 to 2007, each with different initial conditions, with global SST forcing.

[1] The VIC model is a hydrologic model that solves for both water and energy balances and includes subgrid-scale variations in soil moisture capacity, precipitation, vegetation, and topography. It includes a number of vegetation classes and has a detailed calculation of evapotranspiration that depends on vegetation characteristics. The model also includes a detailed treatment of snow, vertical exchanges at the surface and between layers, and also horizontal base flow in the bottom of the soil layers.

This is the Global Ocean Global Atmosphere (GOGA) ensemble.
2. A 16-member ensemble from 1856 to 2007 with tropical Pacific (20°S–20°N) SSTs specified and SSTs elsewhere computed using a two-layer ocean model in which the top layer is the mixed layer and has a specified seasonally varying depth (derived from observations) and exchanges heat and mass with the lower layer. Neglected ocean heat transport is accounted for by specified "q-fluxes" in each layer such that the climatological model temperatures in the two layers remain close to those observed. Details can be found in Seager et al. (2005b). This is the Pacific Ocean Global Atmosphere–Mixed Layer (POGA-ML) ensemble.
3. A 16-member ensemble from 1856 to 2007 with tropical Pacific (20°S–20°N) SSTs specified as for POGA-ML but with climatological SSTs outside of this region. This is the POGA ensemble.
4. An 8-member ensemble from 1856 to 2007 with tropical Atlantic (30°S–30°N) SSTs specified and climatological SSTs elsewhere. This is the tropical Atlantic Global Atmosphere (TAGA) ensemble.

The SST forcing is the mixed Kaplan–Hadley dataset as described above. The ensemble members begin with different atmospheric initial conditions on 1 January 1856. Here we primarily focus on the ensemble mean of the model simulations which, for a large enough ensemble, isolates the component common to all ensemble members—that is, the part forced by the underlying SSTs—by averaging over the weather variability that is uncorrelated between the ensemble members. The component that is SST-forced is of particular interest because it is potentially predictable on the time scale of predictability of SST.

To verify that the model simulations are not unique, we also briefly examined the history of precipitation in the Southeast as modeled by five other atmosphere GCMs forced by observed SSTs, although none extend back before the middle of the last century.

c. *Simulations and projections of forced climate change*

To assess whether the recent drought was in anyway related to anthropogenic climate change, and to assess how hydroclimate is projected to change in the future in the Southeast, we use results from 24 models participating in the IPCC AR4 process (Houghton et al. 2007). We analyze the simulations of the twentieth century forced by known and estimated changes in trace gases, solar irradiance and, in some cases, volcanism and land-use change as well as the projections of current-century climate change generated with the Special Report on Emissions Scenarios (SRES) A1B "middle of the road" emissions scenario that has CO_2 emissions slightly decreasing after midcentury and CO_2 concentrations increasing to 680 ppm by 2100.

3. The recent drought in the perspective of the historical record of hydroclimate variations in the Southeast

a. *Characterizing the recent drought*

Figure 1 shows maps of the observed precipitation anomaly for the half-years from November 2005–April 2006 through May–October 2007. The left column shows results from the climate division station data and uses climatology from 1895 to present. The right column uses the combined satellite–gauge data from GPCP relative to the shorter 1979–present climatology. GPCP data are plotted to see the large-scale patterns, including over the tropical Pacific Ocean, in which the Southeast precipitation anomaly is embedded.

The recent drought began in winter 2005/06 and was part of a drying across the southern United States that stretched from Arizona to the Atlantic Ocean. After that, dry conditions persisted in the western United States and in the Southeast through October 2007. The GPCP data indicate that the Southeast drought was associated with varying patterns of precipitation anomalies across the Pacific–North America sector. During November 2005–April 2006 and May–October 2007, there was reduced precipitation in the Pacific intertropical convergence zone (ITCZ) indicative of La Niña–like conditions, whereas in the two intervening years, even as dry conditions persisted in the Southeast, ITCZ precipitation was above normal, consistent with El Niño conditions. These changes in the tropical Pacific precipitation are consistent with SST anomalies there (not shown). Patterns of Atlantic Ocean precipitation also varied throughout the duration of the drought. It is immediately clear that the recent drought was not consistently and closely tied to tropical SST anomalies and the associated patterns of tropical precipitation anomalies.

Although the exact area of the Southeast that was affected by reduced precipitation in the last few years varied, an area average of land within 30°–38°N, 92°–75°W will encompass the main areas. Figure 2 shows the time series of precipitation averaged over this area, according to the climate division data, for the period from 1895 to October 2007. The data have been averaged into November–April and May–October half-years. The recent drought is clear in the time series, but its precipitation reduction does not exceed earlier droughts, including one as recently as 1998–2002.

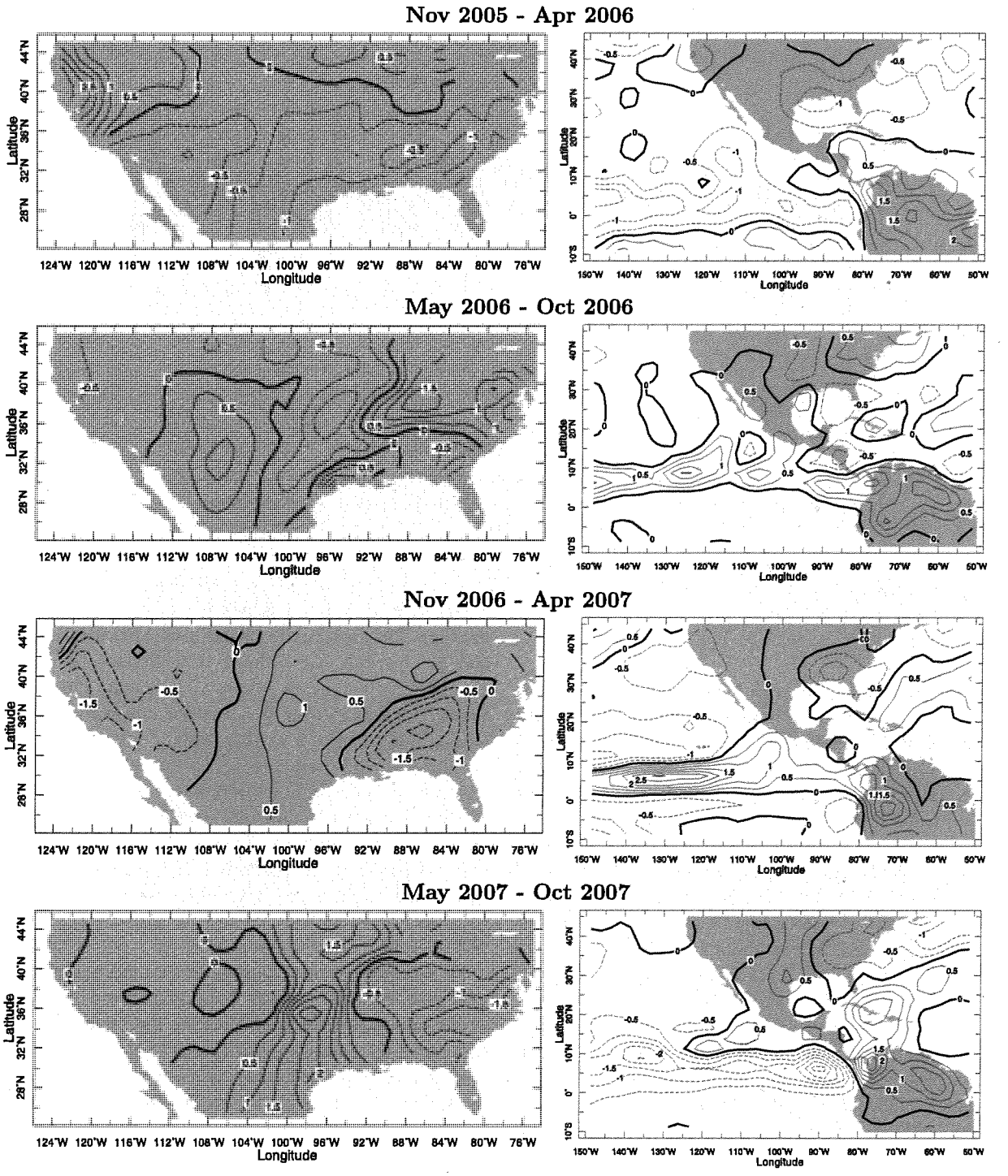

FIG. 1. The precipitation anomaly (mm day^{-1}) for winter and summer half-years from fall 2005 to fall 2007 as derived from (left) climate division station data and (right) GPCP satellite–gauge data. The climate division data are relative to a January 1895–October 2007 climatology, and the GPCP data are relative to a January 1979–March 2008 climatology.

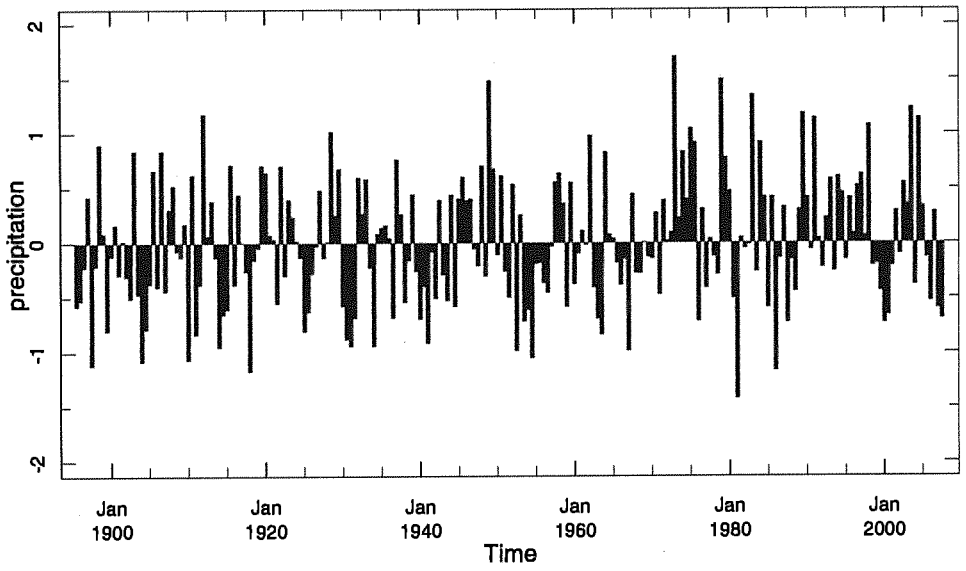

FIG. 2. The area-averaged (30°–38°N, 92°–75°W) precipitation anomalies (mm day^{-1}) for winter and summer half-years from 1895 to fall 2007 as derived from climate division station data. Values are plotted for November–April and May–October half-years and are relative to the 1895–2007 climatology.

b. *Association of Southeast precipitation variations with patterns of SST and sea level pressure variability*

An association between El Niño events and wet winters in the Southeast was noted by Ropelewski and Halpert (1987, 1989, 1996), Wu et al. (2005), Tootle and Piechota (2006), Cocke et al. (2007), and Kurtzman and Scanlon (2007). This relationship, however, does not appear to be stable in time. A time series of the correlation coefficient between winter half-year Southeast precipitation and the Niño-3.4 SST index (SST averaged over 5°S–5°N, 170°–120°W), evaluated in 20- and 30-yr running windows, shows a high, positive correlation after about 1950 and before about 1922 but a weak negative correlation between these periods. Computing correlation coefficients between two time series using running windows is problematic (see Gershunov et al. 2001), which is why we do not show the running correlation plot here), and conclusions that draw on such statistics require independent backup to be credible.

Guided by that suggestive result, to look further into the relationship between winter half-year precipitation variability in the Southeast and global climate variations, we have correlated the time series of precipitation variations in Fig. 2 with SST and SLP variations for three time windows: 1895–1921, 1922–50, and 1951–2004. The ending year of 2004 matches with the ending year of the Hadley Centre SLP data. As shown (Fig. 3), during the winter half year of the early and late periods, wet conditions in the Southeast are associated with a prominent warm SST anomaly—an El Niño—in the tropical Pacific Ocean, but this is not so during the period in between. The associated SLP patterns show, for the early and late periods, anomalously low pressure over the anomalously warm eastern equatorial Pacific and anomalously high SLP over the western equatorial Pacific Ocean, indicative of a weaker Walker circulation. During these periods, there is high pressure over the subtropical North Pacific and low pressure over the subpolar North Pacific, again consistent with El Niño conditions. During the intervening period of 1922–50, the SLP pattern shows strong anomalous high pressure over the North Pacific and no evidence of an altered Walker circulation, consistent with the absence of a tropical Pacific SST anomaly.

These combined results suggest that the winter half-year relationship of Southeast precipitation to global circulation and SSTs varied during the twentieth century, as noted before by Cole and Cook (1998). This is given further support by the regressions and correlations of Hadley Centre SLP data on the Niño-3.4 SST time series (Fig. 4). During the early and late periods, a classic ENSO-driven SLP pattern is seen with a strong Aleutian low and only weak SLP anomalies over the Atlantic Ocean. In contrast, during the 1922–50 period, in addition to the deep Aleutian low, a deep low-pressure anomaly occurs over the Atlantic Ocean during El Niño winters with northerly flow over the Southeast.

It is possible that the Pacific decadal oscillation (PDO) plays a role in the variation over time of the global linkages of Southeast precipitation. The PDO

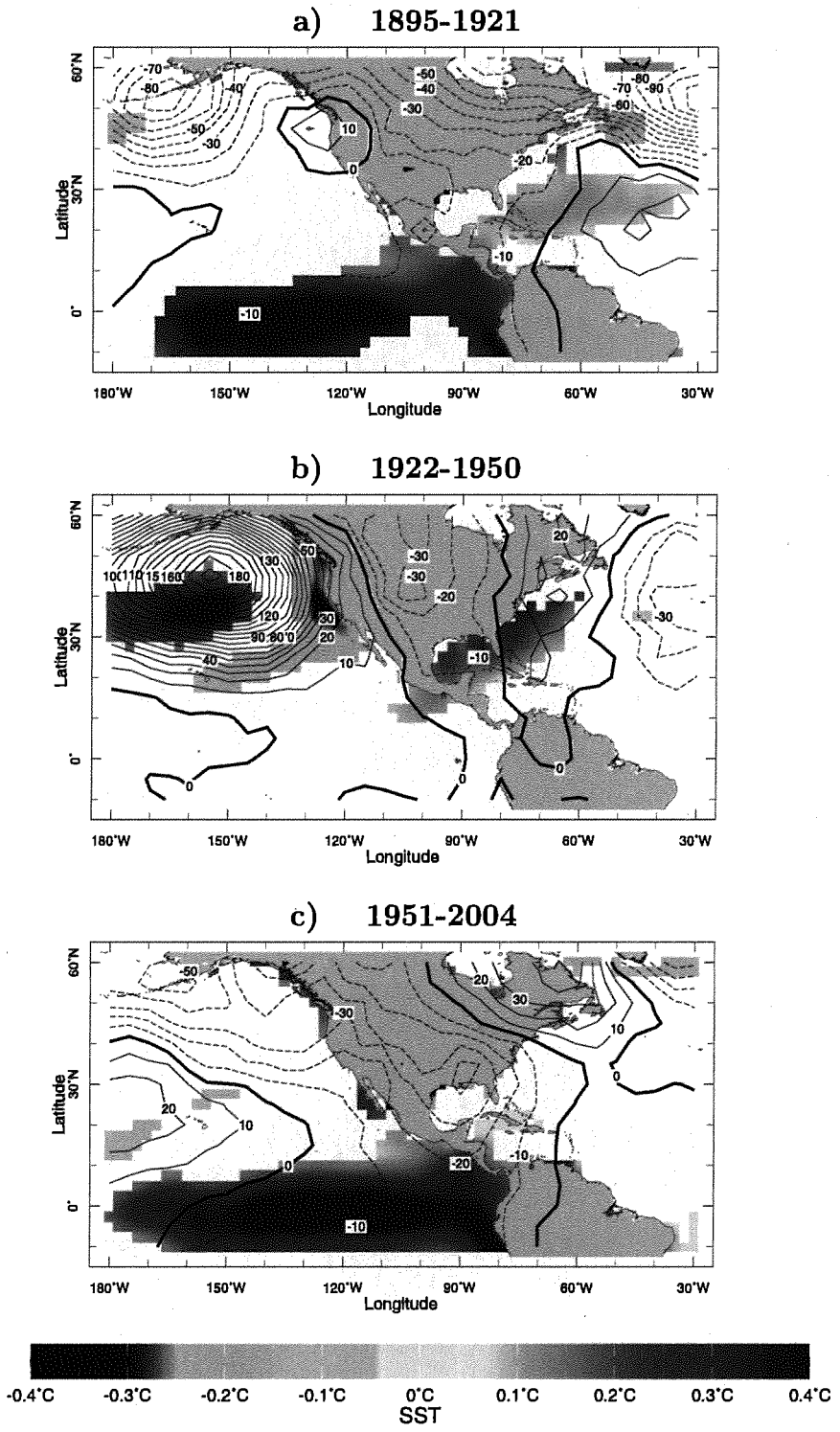

FIG. 3. The regression of the climate division area-averaged Southeast precipitation in November through April on the observed SST (colors, °C) and SLP (contours, Pa). SST values are only plotted where they are statistically significant at the 5% level. Results are shown for three periods: 1895–1921, 1922–50, and 1951–2004.

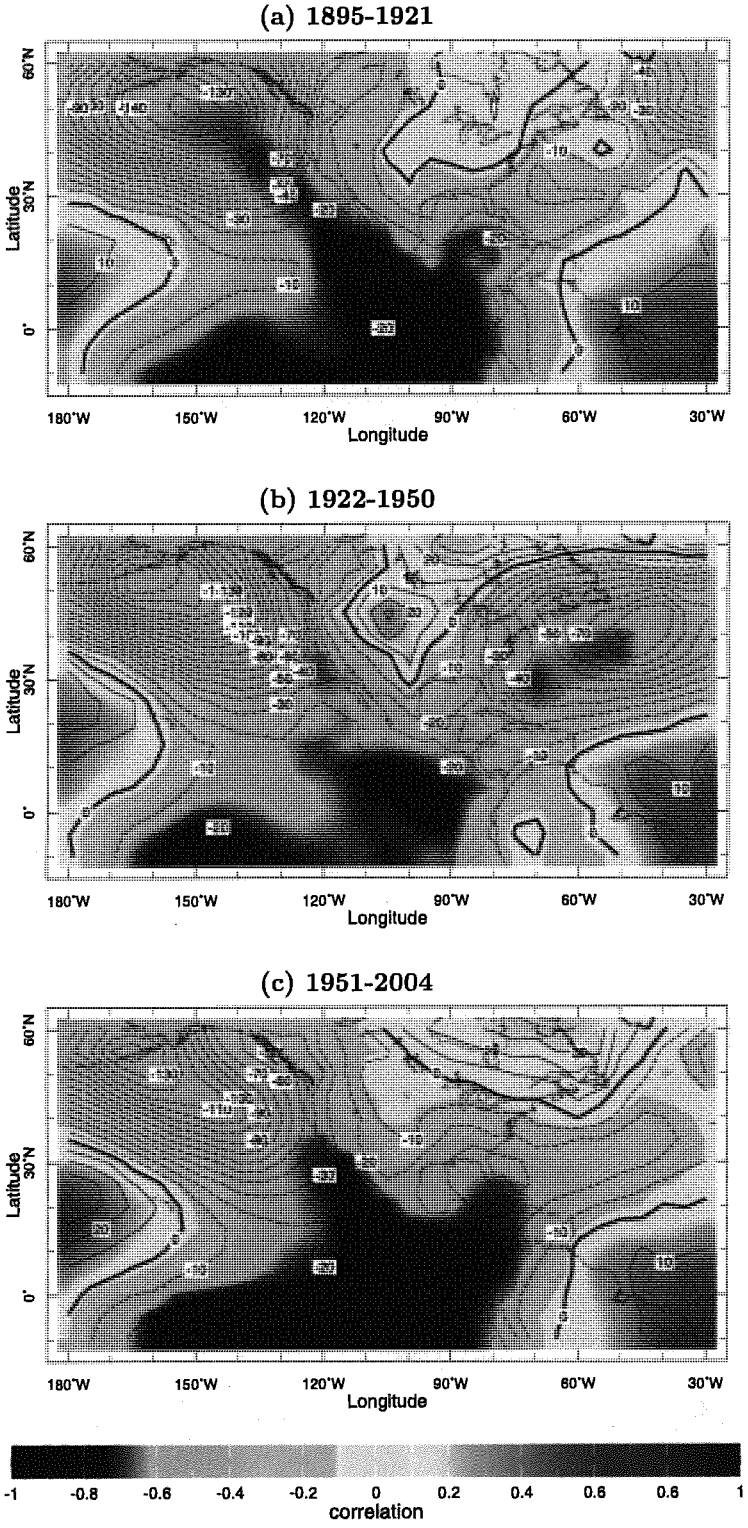

FIG. 4. The regression (contours) and correlation (color) of the Hadley Centre SLP data on the time series of Niño-3.4 SST index for three periods: 1895–1921, 1922–50, and 1951–2004. Units for the regression are Pascals per standard deviation of Niño-3.4. Correlation coefficients of 0.37 (0.49) and 0.27 (0.35) would be significant at the 5% (1%) levels for the first two periods and the final period, respectively, according to a Student's *t* test.

was defined by Mantua et al. (1997) as the first mode in an empirical orthogonal function/principal component analysis of Pacific SST north of 20°N. Between 1922 and 1950, the PDO was primarily positive. The ENSO-associated Atlantic SLP signal during this period is stronger than before or after this period, which is consistent with the PDO "modulation of ENSO teleconnections" discussed by Gershunov and Barnett (1998). Typically El Niño winters cause anomalously wet conditions across the Southeast (Ropelewski and Halpert 1986; Seager et al. 2005a). When climate division precipitation is regressed on the Niño-3.4 SST index, this pattern of overall wetting of the Southeast is reproduced for the pre-1922 and post-1950 periods (not shown). However, for 1922–50 the boundary between wet conditions over the Southeast during El Niño and drier conditions to the north shifts southward into the middle of our Southeast region (not shown). This is potentially consistent with the northerly flow indicated by the SLP regressions on Niño-3.4 for this period (Fig. 4b).

This temporal variability in the ENSO teleconnection, possibly related to lower-frequency Pacific climate variability, may disrupt the tropical Pacific–Southeast precipitation connection during the 1922–50 period. Whether or not this is so, Southeast precipitation variability during this period appears to be controlled by internal atmospheric variability. Indeed, the SST and SLP regression patterns shown in Fig. 3b frequently appear in the extratropically coupled (POGA-ML) model simulations to be discussed later when internal atmospheric variability is isolated by examining departures of ensemble members from the tropical Pacific SST-forced ensemble mean (not shown).

In contrast to the situation during the winter half-year, summer half-year precipitation variability in the Southeast is not strongly associated with tropical Pacific or other SST anomalies at any time since 1895 (Fig. 5). Instead, both the SST and SLP correlations indicate a regionally localized, but temporally variable, association. In general, wet summers in the Southeast are associated with southerly flow anomalies into the region, which presumably brings ascending moist air. The pattern of low-level flow implied by the SLP pattern is consistent with the observed SST anomalies (e.g., anomalous northerly flow over the ocean causing cooling) but these are generally not statistically significant and not seen in Fig. 5. These results are indicative of internal atmospheric variability generating Southeast precipitation variability in the summer half-year and forcing the SST anomalies. This suggests that summer half-year precipitation variability in the Southeast arises from internal atmosphere processes and is essentially unpredictable.

c. *Southeast precipitation–global SST relationships in ensembles of SST-forced atmospheric model simulations*

The observations suggest that during some periods, winter half-year precipitation in the Southeast is closely tied to tropical Pacific SST anomalies but, during other periods, it is not. Any hope for predictability of Southeast precipitation on the seasonal to interannual time scale will require as a first step that the winter link to tropical Pacific SSTs, and its temporal variation, be reproduced in models forced by observed SSTs.

The ensemble mean of the GOGA simulations shows a strong correlation between winter half-year precipitation variations over the Southeast and tropical Pacific SST anomalies for the entire period of the simulations and does not show the 1922–50 observed reversal in correlation. (Individual ensemble members do show time-varying correlations between Niño-3.4 and Southeast precipitation but not with the same temporal behavior. These results could be indicative of a failure of the model to correctly respond to aspects of the observed SST fields but further investigation is beyond the scope of this paper.) Figure 6 shows the correlation and regression of GOGA surface temperature (which, over the ocean, is the observed global SST that was used to force the atmosphere model) and ensemble mean SLP on the ensemble mean GOGA precipitation anomaly for the Southeast (30°–38°N, 92°–75°W, land areas only) for the entire 1856–2007 period. In the model ensemble mean wet winter half-years in the Southeast are clearly associated with El Niño conditions. This is emphasized by the fact that the same relation to SST and SLP is obtained when the analysis is conducted with the POGA-ML model, which has only tropical Pacific SST forcing (Fig. 7). The similarity of the GOGA and POGA-ML results indicates that the model, when forced with global SST anomalies, picked the tropical Pacific anomalies out as having the strongest link to the Southeast. The modeled patterns of SLP and SST associated with wet winters in the Southeast are quite similar to those derived from observations for the pre-1922 and post-1950 periods (Figs. 3 and 4). According to the model, Atlantic SST anomalies do not exert a strong influence on Southeast winter half-year precipitation.

The patterns of GOGA and POGA-ML ensemble mean SLP associated with Niño-3.4 SST anomalies do not vary over time. The single pattern shows the strong North Pacific low during El Niños but does not show the strong low that occurred over the Atlantic in the 1922–50 period (not shown). If ENSO teleconnections varied in time in a way that created a time-varying relation

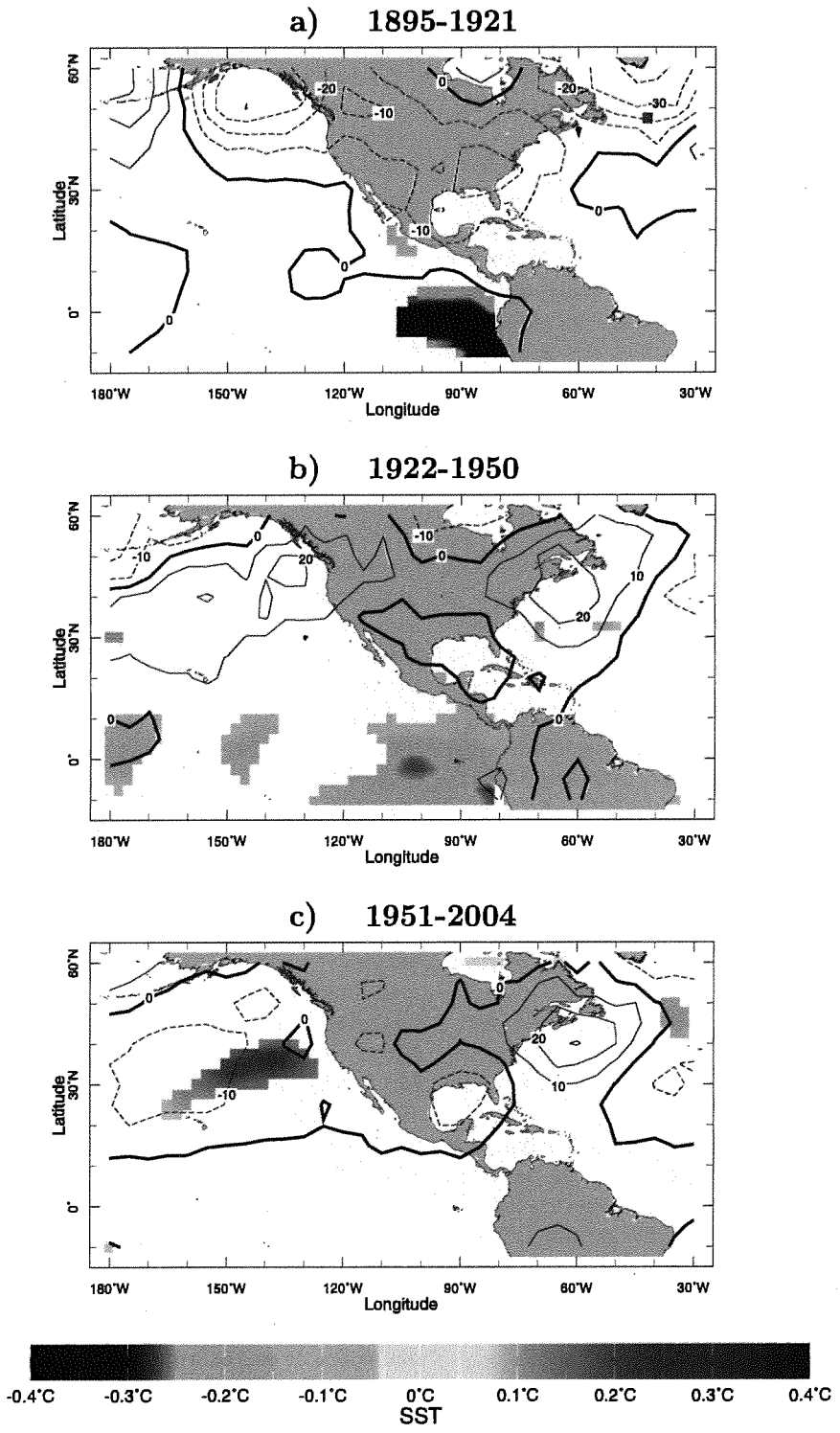

FIG. 5. Same as Fig. 3 but for May through October.

between Southeast precipitation and tropical Pacific SST anomalies, then this is not captured by the model.

The ensemble mean modeled summer half-year precipitation in the Southeast is related to modeled SST and SLP in a manner that looks like a muted version of the winter half-year relationship; that is, wet summer half-years in the Southeast are associated with a warm tropical Pacific Ocean. This is in marked contrast to the

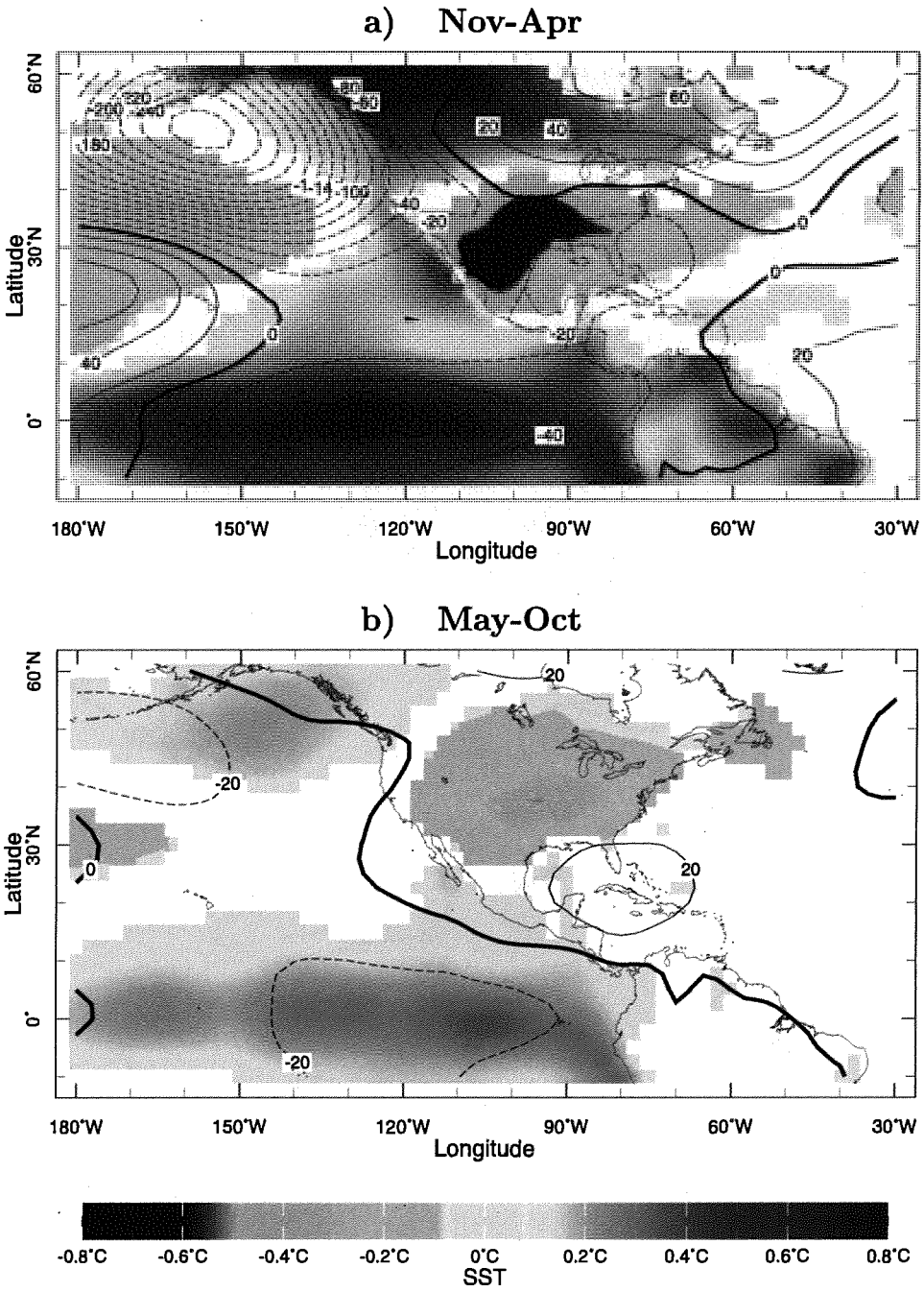

FIG. 6. The regression of the Southeast precipitation of land and SST (colors, °C) and SLP (contours, Pa), all from the GOGA model ensemble mean for the (top) November through April and (bottom) May through October half-years. Surface temperature values are only plotted where they are statistically significant at the 5% level.

observed relationship, which shows no obvious link to the tropical Pacific Ocean. However, the ensemble mean would be expected to emphasize the SST-forced component of Southeast precipitation variability which, if weak, could be overwhelmed in nature by internal atmospheric variability.

d. Large-scale patterns of precipitation variability associated with variability in the Southeast

An additional way to examine the possible causes of precipitation variability in the Southeast is to examine the large-scale patterns of precipitation variability in

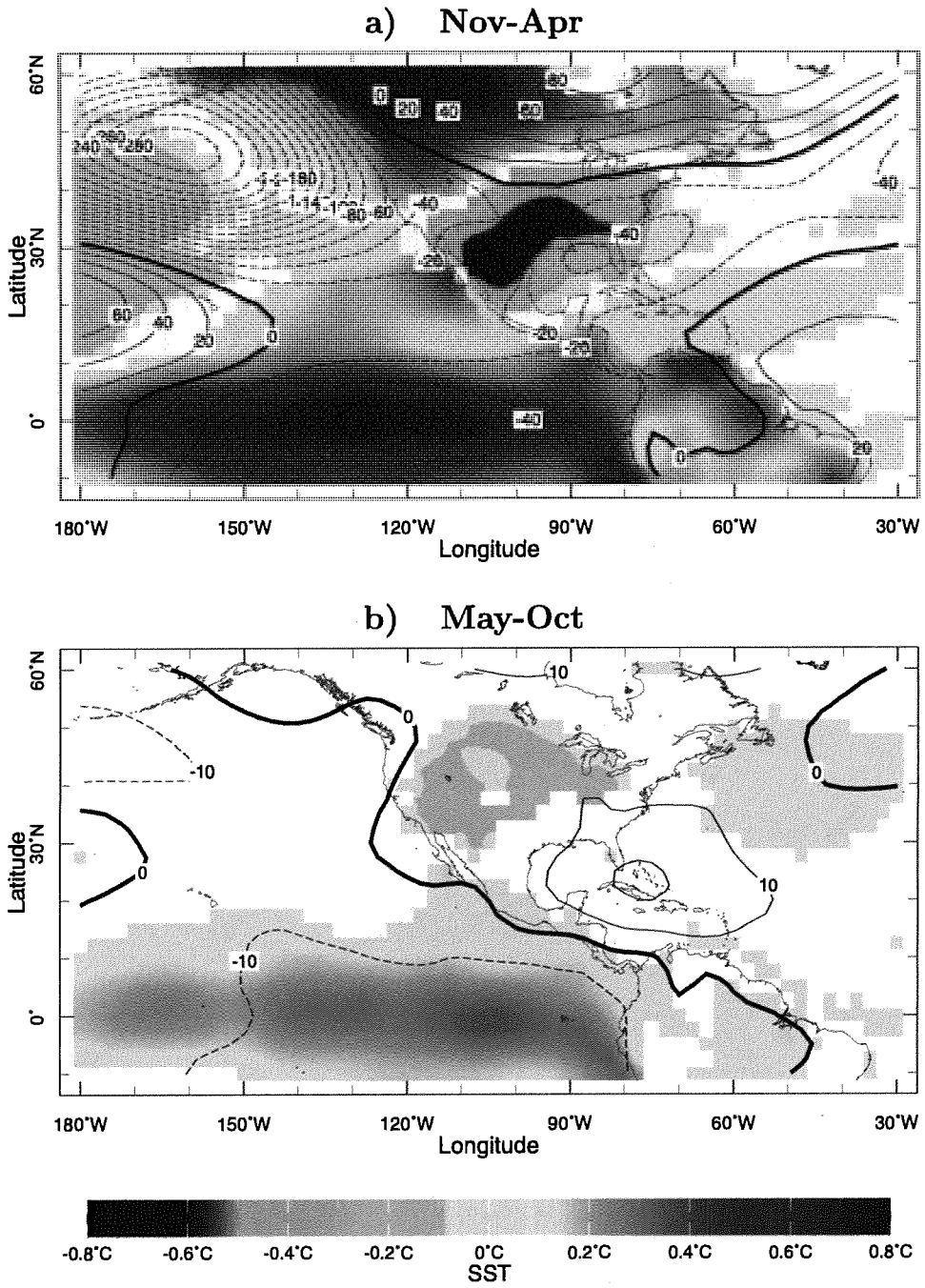

FIG. 7. Same as Fig. 6 but for the POGA-ML model ensemble mean.

which it is embedded. This can only be done with precipitation data over oceans as well as land and therefore we examine the GPCP combined gauge–satellite data from 1979 through 2007 as well as results from the GOGA ensemble mean using data from 1856 to 2007.

The observed winter half-year pattern (Fig. 8) affirms the link of wet Southeast winters to El Niño in the tropical Pacific, as evidenced by the equatorial band of positive precipitation anomaly there. The summer half-year pattern appears largely local and has only a very weak link to the tropical Pacific Ocean. The GOGA modeled winter half-year pattern (Fig. 9), using the entire 1856–2007 record, is also linked to El Niño and is quite realistic (the patterns are not appreciably different when we only use the post-1979 model data to match the shorter observational record). However, during the

summer half-year, the model also produces a link, albeit weaker, between wet in the Southeast and wet over the equatorial Pacific that is at variance with the observations. That said, there is evidence for a summer half-year teleconnection from the tropical Pacific to the Caribbean–Gulf of Mexico–Mexico–southern U.S. region (Seager et al. 2009). However, this teleconnection pattern has a nodal line in its precipitation anomaly close to the Southeast.[2] It is therefore not surprising that in the single realization of nature, any link of summer half-year Southeast precipitation to the tropical Pacific is overwhelmed by internal variability. In contrast, the model ensemble mean, by averaging over the internal variability, shows the weak connection to the tropical Pacific. The spatial patterns obtained from the POGA-ML model (not shown) are essentially the same as those shown from the GOGA model, emphasizing the role of the tropical Pacific in the model.

e. Comparison of ensemble mean modeled and observed history of Southeast precipitation in the instrumental period

The model data comparisons conducted so far suggest that the ensemble means of simulations forced by historical SSTs should be able to capture some part of the observed winter half-year precipitation variations in the Southeast but should have no ability to reproduce the summer half-year variations because those are strongly influenced by internal atmosphere variability. This supposition is confirmed by Fig. 10, which shows the time series of observed climate division and GOGA ensemble mean modeled precipitation for the summer and winter half-years for the Southeast. The correlation coefficient between the winter half-year observed and ensemble mean modeled time series is very low—only 0.13—indicating the model is capturing only a very small part of the observed variance since 1895. However, as expected given the time-varying strength of the Southeast precipitation–ENSO connection (Fig. 3), the correlation coefficient varies between 0.33 for the 1951–2007 period, 0.32 for the pre-1922 period, and −0.41 for the 1922–50 period.

As expected, the modeled and observed summer half-year precipitation time series are uncorrelated (Fig. 10). This is consistent with summer precipitation variations in the Southeast arising from internal atmospheric variability and not from SST forcing. This is in part because the Southeast lies between an area to its west where summer precipitation is positively correlated with tropical Pacific SSTs and an area to its east and south that is negatively correlated (see Seager et al. 2009). In both half-years, the modeled precipitation variability is weaker than that observed, as evidenced by the frequent excursions of the latter outside of the two standard deviation spread of the model ensemble (as shown by the shaded area in Fig. 10).

It is interesting that, despite its proximity to the Atlantic Ocean, neither observational analysis nor the model results have indicated an influence of SST anomalies on Southeast precipitation. This is confirmed by the TAGA ensemble, which produces only very weak precipitation anomalies over the Southeast that are poorly or not correlated with observations (not shown). The POGA-ML ensemble allows Atlantic SSTs to respond to tropical Pacific forcing, which has been shown to create a negative feedback on precipitation over western North America. However, when the tropical Pacific SST forcing is isolated in the POGA ensemble, the results for the Southeast (not shown) are not significantly changed from the coupled POGA-ML ensemble, emphasizing the direct effect of the Pacific on the Southeast.

These results are not unique to this model. We also created plots like Fig. 10 for ensembles of historical model simulations archived at the International Research Institute for Climate and Society (available online at http://iridl.ldeo.columbia.edu/docfind/databrief/cat-sim.html): the Center for Ocean–Land–Atmosphere Studies (COLA) model (10 members, 1950–2003); the National Aeronautics and Space Administration's (NASA) Seasonal-to-Interannual Prediction Program (NSIPP) model (9 members, 1930–2008); the European Centre for Medium Range Weather Forecasts–Hamburg, version 4.5 (ECHAM4.5) model (24 members, 1950–2007); the Geophysical Fluid Dynamics Laboratory atmospheric model 2.1 (GFDL AM2.1; 10 members, 1950–1999); and the NCEP model (10 members, 1950–2004). The correlation coefficients between modeled and observed winter half-year precipitation (for the same southeastern land area as used before) were 0.20 for NSIPP, 0.27 for COLA, 0.42 for ECHAM4.5, 0.38 for GFDL, and 0.22 for NCEP. These are comparable to that from our GOGA simulations, given that the other models primarily contain the late-twentieth-century period of highest correlation.

Summer half-year precipitation was essentially uncorrelated, or even weakly negatively correlated, with

[2] Indeed, by moving the longitude ranges of the box used to define the Southeast precipitation index, or even by including ocean points within the range used, wet conditions become correlated with La Niña in the tropical Pacific as the precipitation index picks up the coherent region of precipitation teleconnection that extends from east of the southeastern United States southward, eastward, and westward over the Gulf of Mexico, Caribbean Sea, and adjacent Atlantic Ocean.

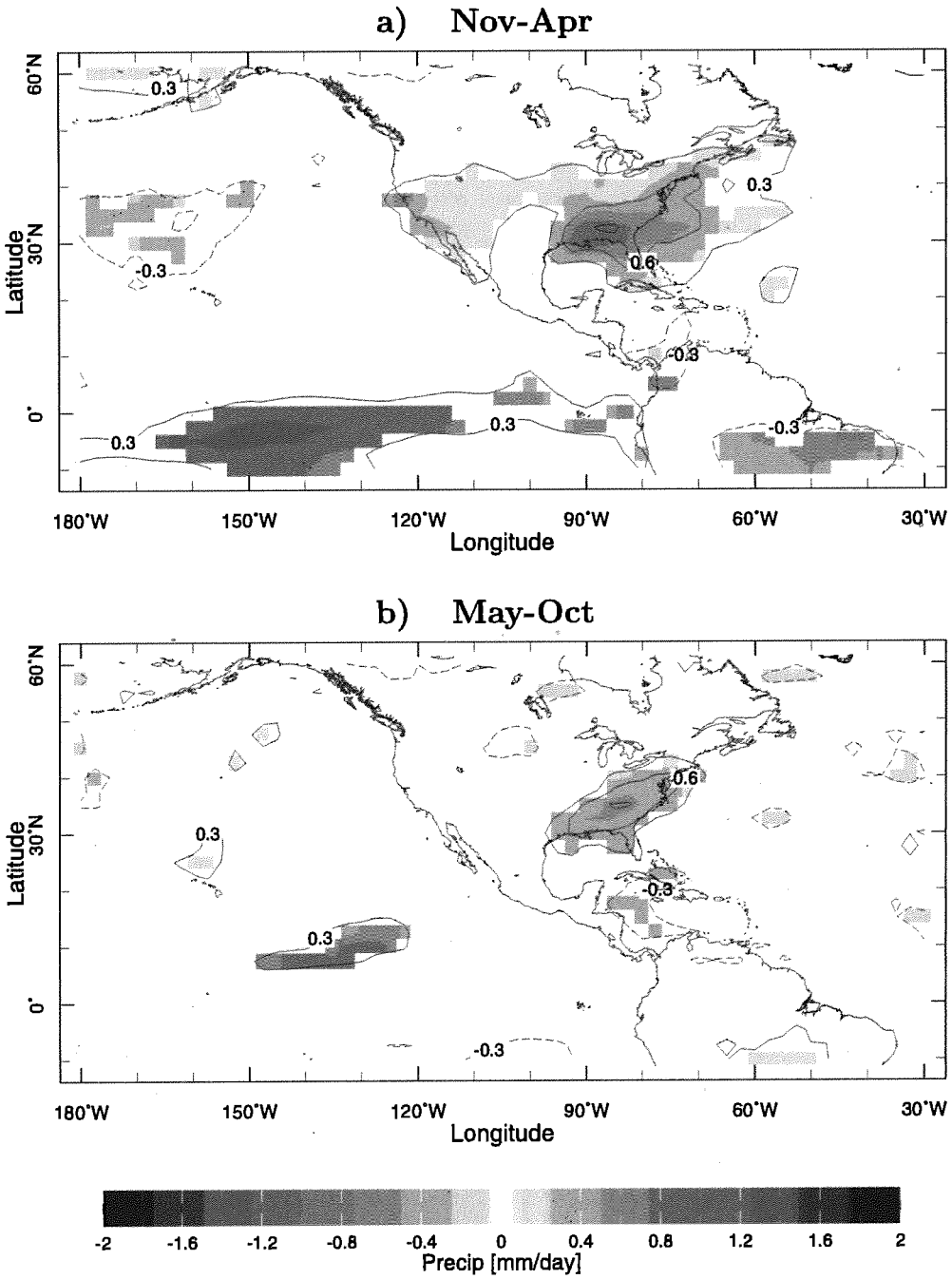

FIG. 8. The regression (and correlation between GPCP satellite–gauge precipitation and an index of that over the Southeast for the (top) November through April and (bottom) May through October half-years using data from 1979 through 2007. The regression coefficients (colors) are only plotted where significant at the 5% level, and the correlation coefficient is contoured. Units for the regression are millimeters per day per standard deviation of the Southeast precipitation index.

observations for four of these additional models; however, it reached 0.29 for the NCEP model. Unlike the other models, precipitation in the Southeast in the NCEP model was weakly correlated to La Niña conditions. However, there is no evidence from the observational analyses presented here, or from an analysis of the spatial pattern of ENSO-associated GPCP precipitation anomalies, that this is a generally correct or robust relationship and therefore we avoid the conclusion that the NCEP model is right and the other five models are wrong.

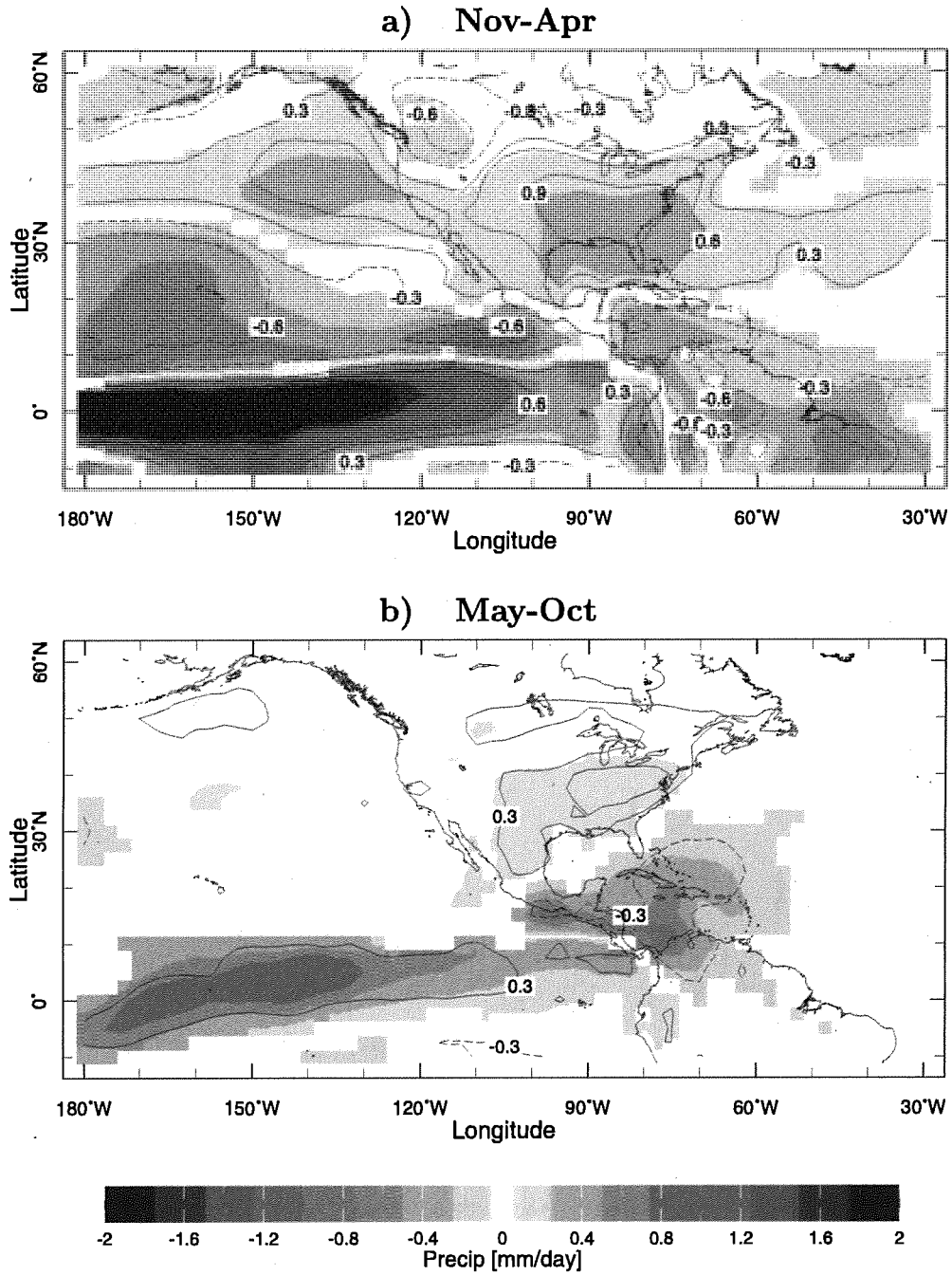

FIG. 9. Same as Fig. 9 but for the ensemble mean of the GOGA simulations. Units for the regression are millimeters per day per standard deviation of the GOGA Southeast precipitation index.

Given the weak relationship between Southeast precipitation and SSTs, and the varying SST conditions in the tropical Pacific Ocean during the 2005–07 period, it is not surprising that the GOGA model fails to accurately reproduce a continuous drought from winter 2005/06 through fall 2007. The modeled precipitation anomalies are shown in Fig. 11 (cf. Fig. 1) and show a very limited hindcast skill. Of the four half-years that made up the drought period, only the La Niña–associated dry winter of 2005/06 is convincingly simulated. In contrast, the model conspicuously fails to simulate the dry Southeast from November 2006 through October 2007. The simulations from the tropical Pacific–forced-only model (POGA-ML) are also shown in Fig. 11 and

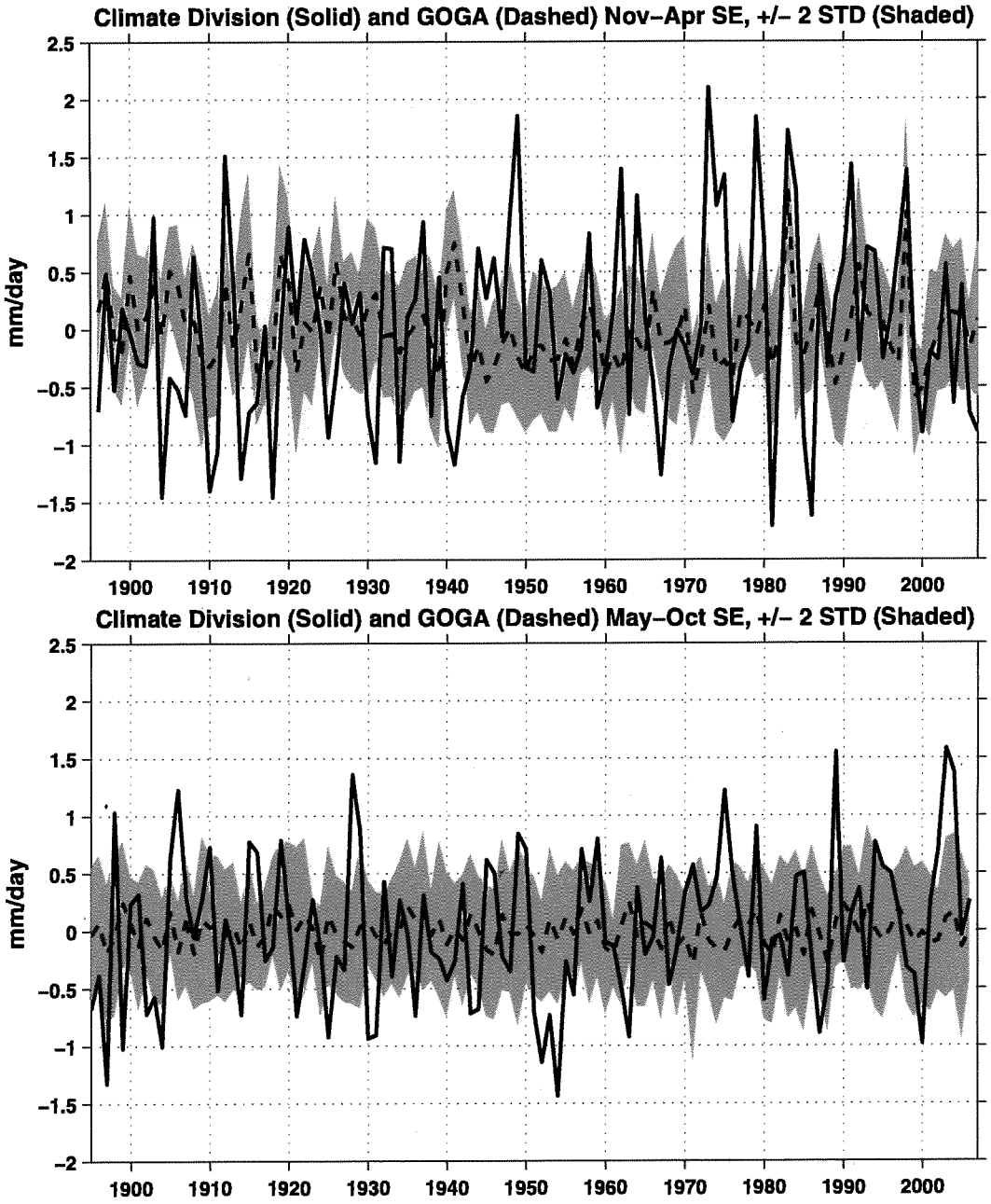

FIG. 10. Time series of the climate division precipitation averaged over the Southeast and that of the GOGA ensemble mean (mm day^{-1}) for the (top) winter and (bottom) summer half-years. The shading around the model time series shows the plus and minus two standard deviation of the spread within the model ensemble. Model skill is weak (nonexistent) during the winter (summer) half-years.

are essentially very similar to the results obtained with global SST forcing, emphasizing the dominance in the model of the tropical Pacific forcing. The only two other models that cover the recent drought—NSIPP and ECHAM4.5—produced similar results (not shown).

In contrast to the failure of the model to simulate the post-2005 drought as a response to SST forcing, Fig. 10 shows that the preceding turn-of-the-century drought was more accurately simulated during the winter half-year by the GOGA model [and also by the other models (not shown)] probably because, in nature and the model, this was a response to a continuous 4-yr La Niña (Hoerling and Kumar 2003; Seager 2007).

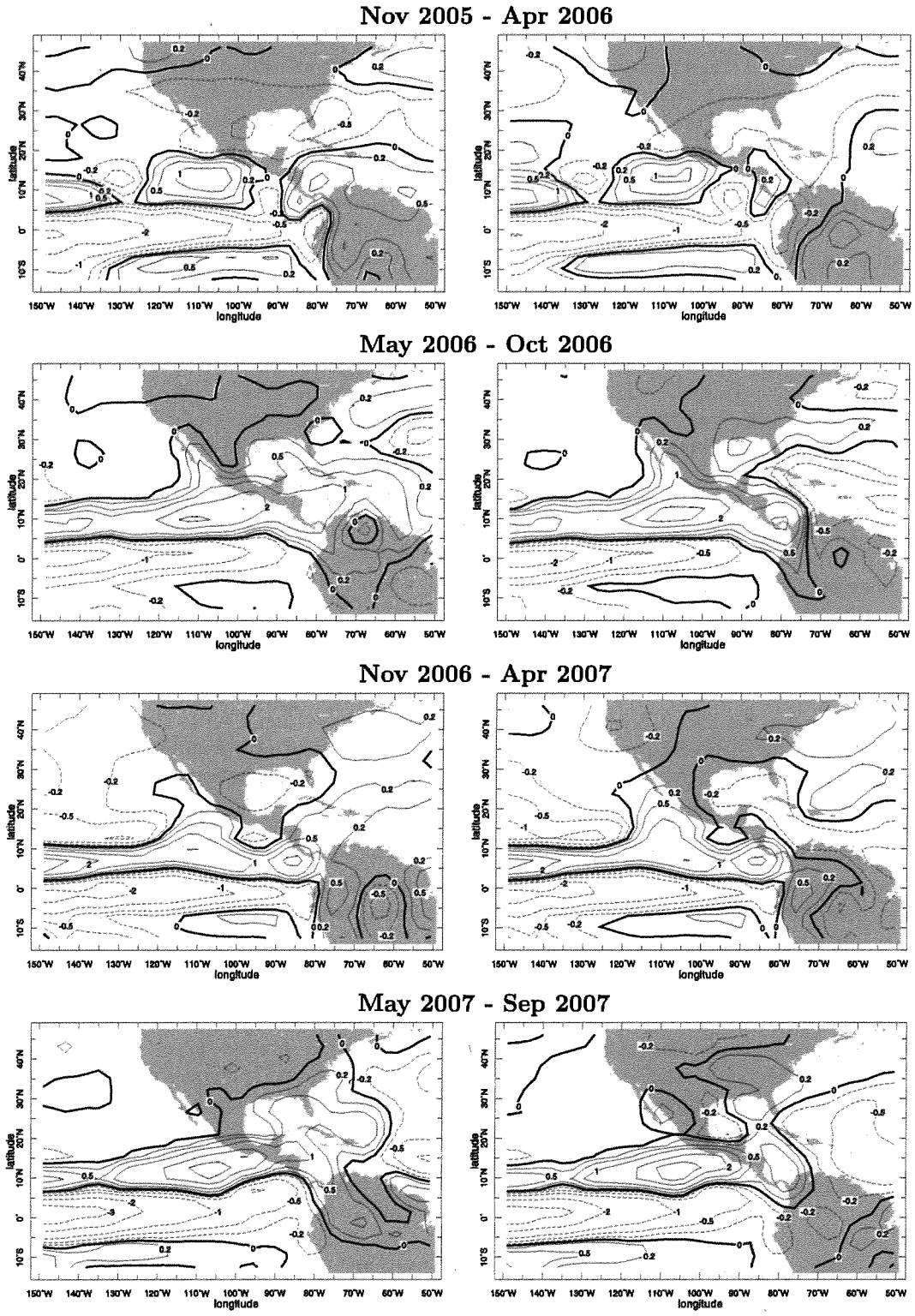

FIG. 11. The modeled precipitation anomalies (mm day^{-1}) for half-years from winter 2005/06 through 2007 for the case of (left) global SST forcing (GOGA) and (right) tropical Pacific forcing alone (POGA-ML). Results are shown for the Pacific–North America–Atlantic domain, and anomalies are relative to a post-1979 climatology to facilitate comparison to the satellite–gauge results shown in Fig. 1.

f. Summary: Causes of Southeastern drought

The observational record that winter precipitation in the Southeast is tied to ENSO, as has been noted by many before, beginning with Ropelewski and Halpert (1987), is supported in a cause-and-effect manner by modeling experiments in which times of cool tropical Pacific SSTs force drier-than-normal conditions in the Southeast. However, this relationship is weak in the observational record and, what is more, was not operative at all between about 1922 and 1950, during which time Southeast precipitation does not appear to be controlled by any known mode of SST-forced climate variability. In contrast, the model ensemble mean produces a very stable relation between cool tropical Pacific SST anomalies and dry SST anomalies in the Southeast.

These results can be reconciled by recognizing that, even during the time of an active ENSO–Southeast precipitation relation, ENSO explains at most a quarter of the Southeast precipitation variance. The model ensemble mean isolates the SST-forced signal and, by design, produces a stronger ENSO–Southeast precipitation relation. During the approximately 1922–1950 period, the modest ENSO-forced signal in Southeast precipitation was not evident. The results of Gershunov and Barnett (1998) suggest that the dominantly positive PDO during this time acted to weaken the ENSO–Southeast precipitation link, leaving winter half-year precipitation variability in nature to be dominated by internal atmosphere variability, which the model ensemble mean, by design, filters out.

In the summer half-year, the observed precipitation variations seem only related to internal atmosphere variability and not to any SST forcing. In contrast, the model creates wetter-than-normal summer half-years when tropical Pacific SSTs are warm. This would lead to a spurious prediction, but the large ensemble spread and weak correlation would caution about placing any faith in the ensemble mean prediction. Consistent with these results is that the time history of modeled and observed precipitation in the Southeast shows only weak agreement in the winter half-year and no agreement in the summer half-year. Similarly, low model skill was obtained when examining simulations conducted for shorter periods of time with five other climate models and confirms the limited potential predictability of Southeast precipitation in winter and its unpredictability in summer.

The atmospheric dynamics that link tropical SSTs to precipitation variations in the North American and global extratropics have been analyzed in detail elsewhere (Seager et al. 2003; 2005a,b; Cook et al. 2007; Seager 2007; Seager et al. 2009) and will not be further examined here.

4. Long tree-ring records of drought in the Southeast

Does the short instrumental record capture all that can happen in the Southeast, or can droughts more serious than any in the instrumental record occur? To examine this question, we used an updated (by the inclusion of more tree-ring records; Ed Cook 2007, personal communications) version of the NADA, which provides tree-ring reconstructed summer PDSI for each year from 2 B.C. to A.D. 2006 (Cook and Krusic 2004; Cook et al. 2004). Before A.D. 1000, coverage is largely restricted to western North America, and here we examine the period from A.D. 1000 onward. Before proceeding we correlated the tree-ring reconstructed PDSI with the climate division precipitation data for the overlapping post-1895 period. The tree-ring PDSI correlated equally well with summer and winter half-year precipitation with a correlation coefficient of about 0.5 for both, or about a quarter of the variance being explained. Winter and summer precipitation are not well correlated in the Southeast. Consequently, a total of about half the tree-ring PDSI variance is explained by precipitation variations, with precipitation in each of the two half-years being about equally responsible. This is comparable to the correlation between precipitation and instrumental PDSI that Karnauskas et al. (2008) found for the Great Plains. The summer and winter correlations also suggest that the trees in the Southeast are sensitive to precipitation year around and therefore we think of the PDSI values as indicative of the annual moisture balance.

As shown in Fig. 12, the Southeast has experienced a rich amount of temporal hydroclimate variability over the last millennium. The dataset ends in 2006 and does not capture the recent drought in entirety, but the equally as severe turn-of-the-century drought (Seager 2007) is unremarkable and appears as one of many such short dry spells.

In addition to short and severe droughts, there is evidence of some long multiyear droughts. To search for these droughts, we created a criterion for a drought that begins with a year of negative PDSI and ends the year before a year of positive PDSI and in the intervening period contains no back-to-back years of positive PDSI. We then calculated the cumulative PDSI over the drought, so defined, and ranked the results. Maps of the selected droughts are shown in Fig. 13 along with the map of the NADA estimate of the 1998–2002 drought for reference. Two droughts—from 1798 to 1826 and from 1834 to 1861—appear as extended dry periods. The mid-nineteenth-century drought was centered in the Southeast, whereas the earlier nineteenth-century drought was centered in the central plains but

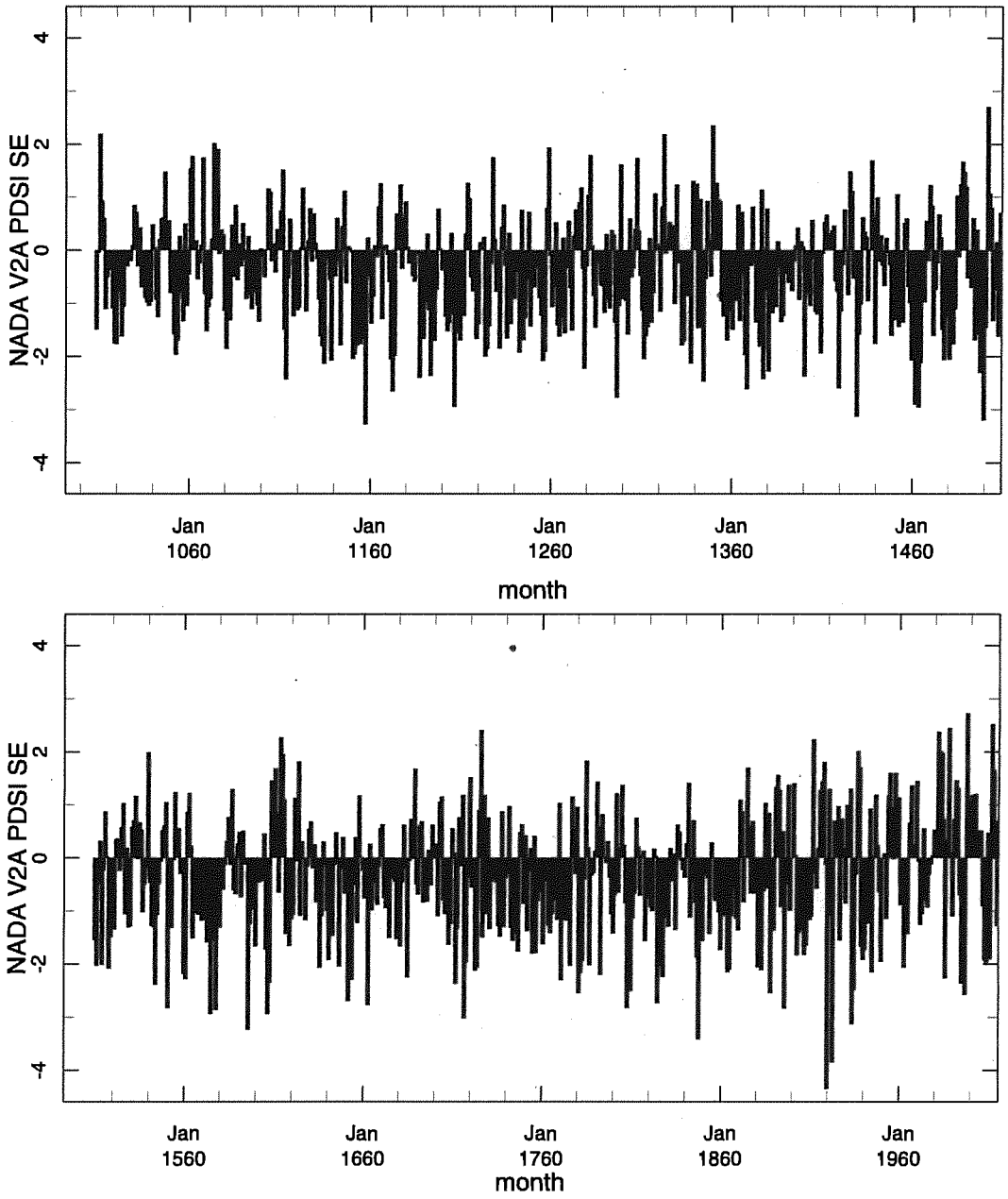

FIG. 12. The tree-ring reconstructed PDSI averaged over the Southeast for the A.D. 1000–2006 period from the updated NADA.

spread both east and west from there. In contrast, a strong and uninterrupted drought occurred in the eastern plains between 1555 and 1574 and also affected the Southeast but not the western United States. This drought corresponds to the earlier part of the sixteenth-century megadrought identified by Stahle et al. (2000, 2007). In contrast yet again, the two medieval-era droughts selected affected both the West and the Southeast and are more akin in spatial pattern to prior identified medieval "megadroughts" (Herweijer et al. 2007; Seager et al. 2007a). The PDSI averaged over these droughts does not reach the severity of the 1998–2002 period, but the selected droughts generally include shorter periods within them of that severity and are much longer than the turn-of-the-century drought.

The early- and mid-nineteenth-century droughts are clearly seen in Fig. 12, and each drought included a few years with drought severity comparable or exceeding those in the turn-of-the-century drought and, more importantly, for 29 and 28 yr, respectively, each had

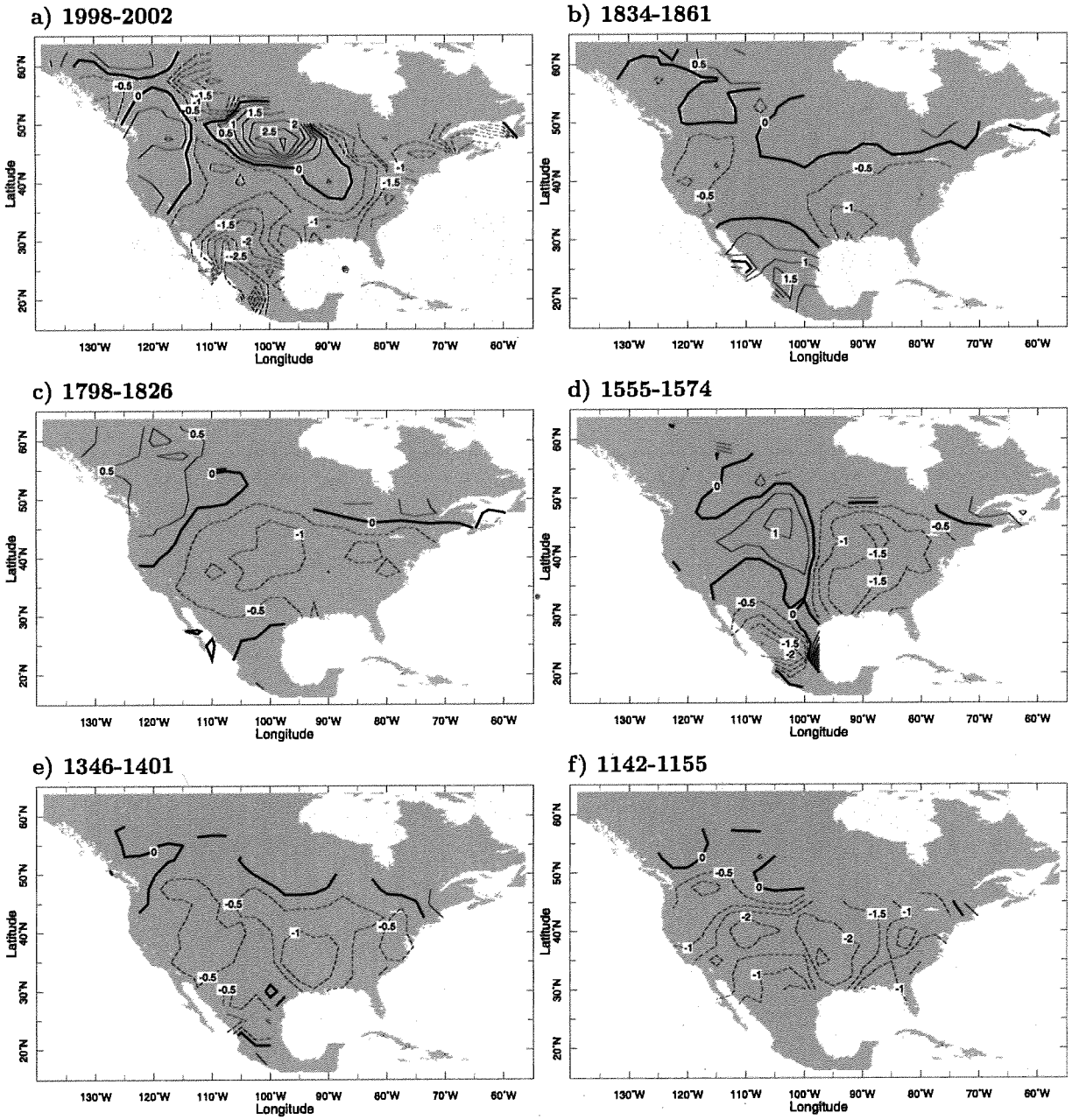

FIG. 13. Tree-ring reconstructions of PDSI for the turn-of-the-century drought and for five previous multiyear droughts as recorded in the NADA. The five earlier droughts were chosen on the basis of both longevity and intensity to illustrate the potential in the Southeast for multiyear–decadal time-scale droughts to occur.

overwhelmingly negative PDSI years and no years with more than extremely small positive PDSI. These nineteenth-century droughts, which are perhaps better thought of as a single multidecadal dry period, are well within the range of historical records and could potentially have had an agricultural effect but probably would not have had an effect on water availability for people given the generally wet climate of the Southeast and the much smaller population then as opposed to now. We are unaware of historical records of these droughts.

The causes of these long and severe droughts within the last millennium are not well known. The two widespread medieval-period droughts are potentially linked to cool tropical Pacific SSTs during those centuries (Cobb et al. 2003) according to mechanisms analogous to La Niña forcing of multiyear droughts (Cook et al.

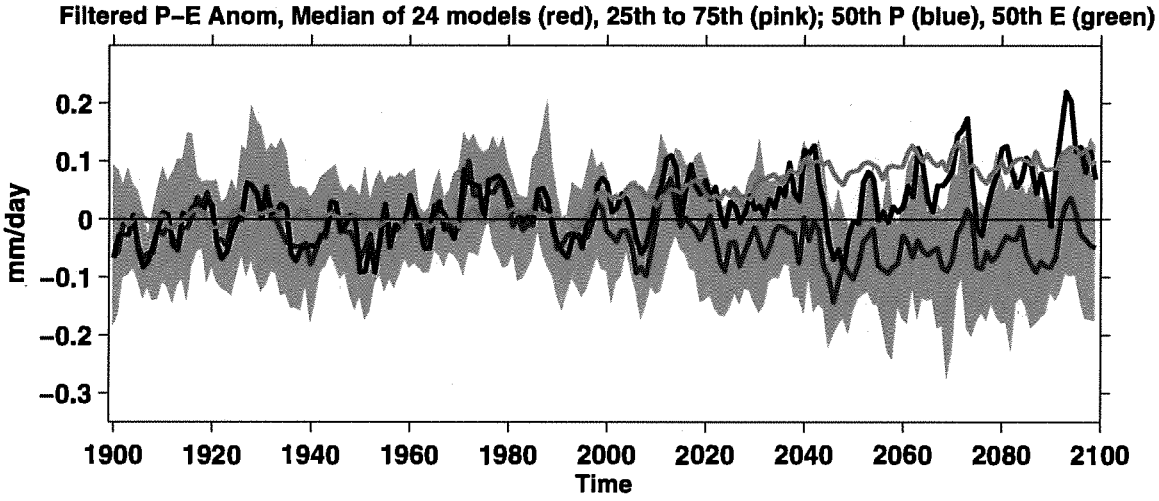

FIG. 14. Modeled changes (mm day^{-1}) in annual mean $P - E$ over the Southeast (30°–38°N, 92°–75°W, land areas only) averaged over ensemble members for each of the 24 models. The historical period used known and estimated climate forcings, and the projections used the SRES A1B emissions scenario. The red line shows the median $P - E$, and the pink shading shows the 25th and 75th percentiles of the $P - E$ distribution among the models. The ensemble medians of P (blue line) and E (green line) are also shown. Results are for the period common to all models (1900–2098) and anomalies for each model are relative to that model's climatology for 1950–2000. Results have been 6-yr low-pass Butterworth filtered to emphasize low-frequency variability. The climatological 1950–1999 model ensemble mean $P - E$ in this region is around 0.8 mm day^{-1}.

2007; Herweijer et al. 2007; Seager et al. 2007a; Graham et al. 2007; Seager et al. 2008a) that created coast-to-coast droughts across southern North America. The link between the tropical oceans and the later droughts has not yet been examined. There is no indication in the record of a multicentennial medieval period of drier conditions in the Southeast as there is in the West (Cook et al. 2004; Herweijer et al. 2007; Seager et al. 2007a). However, it does seem that the twentieth century has, from the perspective of the millennium, been anomalously wet overall.

5. Model projections of anthropogenic hydroclimate change in the Southeast

There is no clear evidence of hydroclimate change in the Southeast during the period of anthropogenic forcing of climate (Fig. 2), but it is worth examining model projections of twentieth- and current-century change. To do this we have examined the simulations of the climate of the last century and projections of the climate of the current century that were done as part of the IPCC AR4 process. We examined results from all 24 models. Since for some models there are multiple simulations and projections and since we did not want to bias the results to any particular model, we only examined a single twentieth-century run and a single twenty-first-century run for each model. Figure 14 shows time series of the annual mean medians of precipitation (P) and evaporation (E) from the multimodel ensemble as well as the median, and upper and lower quartiles, of the distribution of $P - E$.

The median projection for the Southeast is for both increasing P and E. The balance is such that the median $P - E$ decreases very modestly during this century; $P - E$ drops more in the summer half-year than the winter half-year (not shown). However, the range of model projections is large with a quarter to a third of the models projecting an increase of $P - E$. Indeed, when the same 19 models as used by Seager et al. (2007b) are analyzed, a more striking reduction of $P - E$ appears, whereas a 12-member subset of models analyzed by Milly et al. (2005) shows an increase in implied runoff (and hence, presumably, in $P - E$) in the current century.

For the full 24-model ensemble, Fig. 15 shows maps of the annual mean change in P and $P - E$ for the near-future period from 2021–40 minus the period from 1950 to 1999. The Southeast clearly lies at the poleward fringe of the region of projected subtropical drying (Held and Soden 2006). In both half-years, P increases over the Southeast in the projected near future. However, $P - E$ drops across the region in the summer half-year and for the southern part of the region in the winter half-year. Remembering that long-term mean $P - E$ is always positive over land, the reduction in $P - E$ implies less atmospheric convergence of moisture into the region in the near future. Since P itself increases, this is driven by increased evaporation of fallen P and its removal as vapor by the atmospheric flow. This is a very different

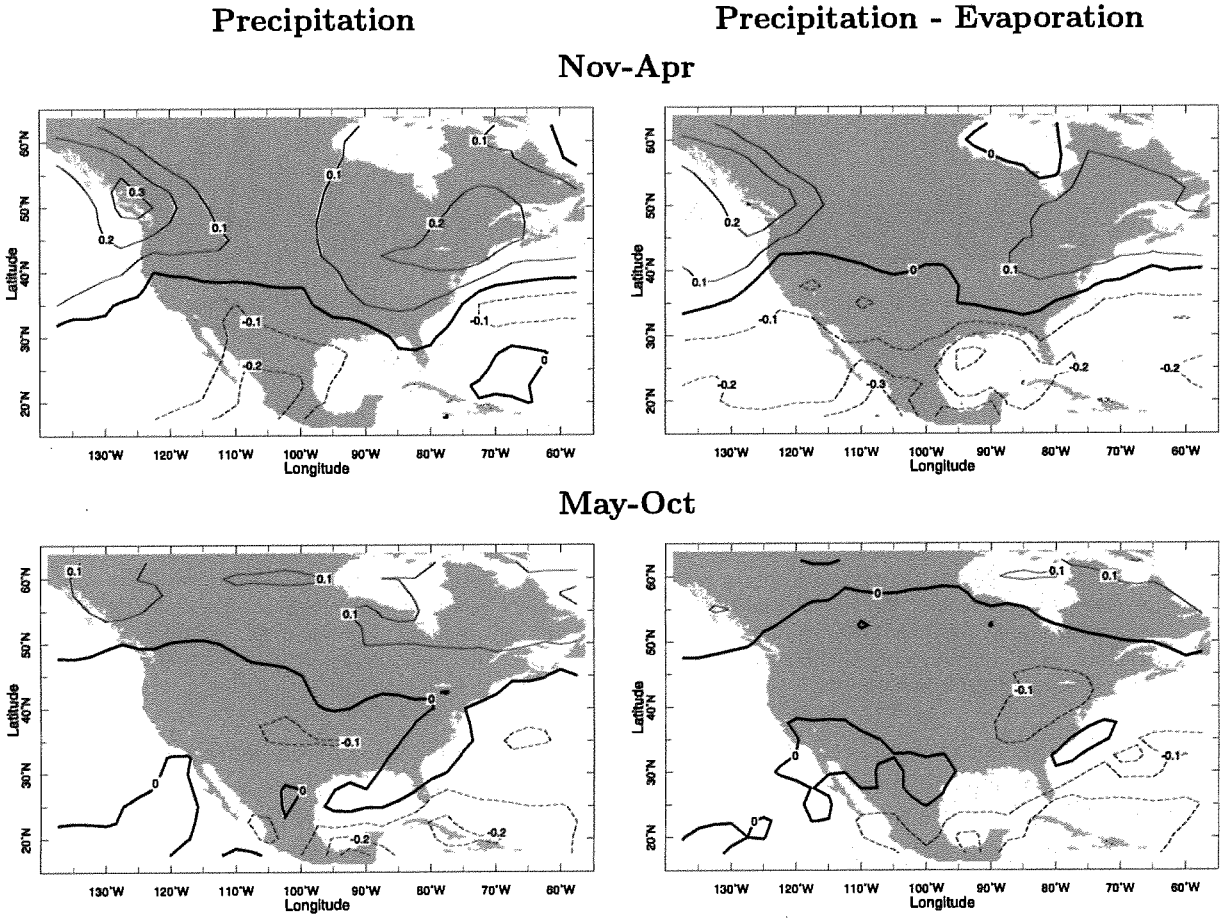

FIG. 15. The change (mm day^{-1}) in (left) P (left) and (right) $P - E$ for 2021–40 minus 1950–99 as projected by the ensemble mean of 24 IPCC AR4 models using the SRES A1B emissions scenario for the current century. Results are shown for the (top) winter and (bottom) summer half-years.

situation to the Southwest, where the projected reduction of $P - E$ is driven by a projected reduction of P and E reduces as the land surface dries (Seager et al. 2007b).

6. Conclusions

The recent 2-yr drought that struck the Southeast, by summer and fall 2007, had caused serious water shortages in the region, leading to the imposition of restrictions on water use and the opening up of legal conflicts within and between states on the regulation and use of the region's water resources. This is despite this 2-yr drought not being more severe than earlier droughts, including one as recently as 1998–2002, and indicates that the water shortage crisis was largely driven by rising demand.

Observed precipitation variations in the Southeast are weakly associated with ENSO during the winter half-year, with La Niña leading to dry conditions, and are instead correlated to only internal atmospheric variability in the summer half-year. A climate model forced by historical SSTs recreates the weak La Niña-dry Southeast link in the winter half-year but also creates this link, in a muted fashion, in the summer half-year. Apparently any such weak ENSO-preciptation link in the summer in observations is overwhelmed by internal atmospheric variability. The observed ENSO-winter precipitation link also varies in time being weak and of opposite sign from 1922 to 1950, a feature that is not recreated by the model ensemble mean or by ensemble members.

All of this emphasizes the weakness of the ENSO–Southeast precipitation link, which is in contrast to a much stronger link for southwestern North America (see Seager et al. 2005a,b; Herweijer et al. 2006; Schubert et al. 2004a,b; Seager 2007; Seager et al. 2009. As a consequence, the time history of modeled and observed area-averaged Southeast precipitation is only weakly correlated in winter and not at all in summer. This weak temporal correlation was confirmed in five other climate

model simulations. That there are multidecadal periods when the correlation between observed and modeled precipitation is higher (e.g., after 1950) might suggest some useful model skill, but this cannot be reliably exploited unless for some reason a temporally varying correlation, other than random chance, is discovered and the models can reproduce it. Overall, it appears that predictive skill of Southeast precipitation will be limited in winter and nonexistent in summer.

Despite the inability to usefully predict Southeast precipitation, it is important to assess the full character of precipitation variations in the Southeast. To do this we analyzed tree-ring reconstructions of PDSI for the period from A.D. 1000 to 2006. The tree-ring records show long periods of severe droughts that dwarf the turn-of-the-century drought in their persistence. One of these droughts seems to have occurred in 1555–74 and included 20 uninterrupted years of drought. This drought did not effect western North America. In contrast, the Southeast was also sometimes affected by the medieval megadroughts that were centered in western North America. Curiously, the early and mid-nineteenth century also appears as a long period of drier conditions after which the Southeast transitioned to a twentieth century that was noticeably wetter than the long-term mean of the millennium. The medieval droughts have been linked to persistent La Niña–like conditions in the tropical Pacific Ocean (Cobb et al. 2003; Herweijer et al. 2006; Cook et al. 2007; Graham et al. 2007; Seager et al. 2007a, 2008a), but the sixteenth and early- to mid-nineteenth-century droughts have not yet been attributed to any possible cause. Regardless, the tree-ring records clearly indicate that longer, and by that measure more severe, droughts have occurred in the Southeast than appear in the instrumental record of the twentieth century.

Turning to projections of anthropogenic climate change in the Southeast, models project that, in the near-future precipitation will increase year around in the Southeast north of southern Florida. However, precipitation minus evaporation ($P - E$) decreases modestly in the annual mean, driven by increasingly negative $P - E$ in summer. This is in turn caused by an increase in evaporation, presumably related to atmospheric warming, that exceeds the increase in precipitation. Since $P - E$ is positive over land, this implies a weakening of moisture convergence by the atmospheric flow; however, we have not examined how this occurs. The reduction of $P - E$ is not robust in the sense that at any time up to a third of the models project an increase in $P - E$ while the remaining models projects a decrease.

To the extent that $P - E$ is reduced, the mechanism is different from that for the robust projection of reduced $P - E$ in the Southwest, which is driven by reduced P, with E reducing as soil moisture drops (Seager et al. 2007b). In the post-2005 drought, according to the NCEP reanalysis, E dropped along with P, indicating that the recent drought was driven by a reduction of P and not by an increase of E. Furthermore, the trends in E for the 1949–2008 period computed from the NCEP reanalysis, and computed for the 1915–2003 period from the VIC land surface hydrology model, do not show an increase in E. These estimates of E are likely to be quite uncertain, although the estimate from the VIC model is at least constrained by the observed precipitation, but they are consistent in showing no signature of projected anthropogenic climate change in the recent drought. That said, the projection of a modest reduction in the current century of $P - E$ by the model ensemble indicates that climate change should not be counted on to solve the Southeast's water woes and is, in fact, as likely to make matters worse as it is better.

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A Global Model of Climate Change Impacts on Timber Markets

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Several papers have now estimated the impact of climate change on national timber markets, but few studies have measured impacts globally. Further, the literature on impacts has focused heavily on changes in productivity and has not integrated movements of biomes as well. Here, a dynamic model of ecological change and economic change is developed to capture the impact of climate change on world timber markets. Climate change is predicted to increase global timber production as producers in low-mid latitude forests react quickly with more productive short-rotation plantations, driving down timber prices. Producers in mid-high latitude forests, in contrast, are likely to be hurt by the lower prices, dieback, and slower productivity increases because of long-rotation species. Consumers in all regions benefit from the lower prices, and the overall impacts of climate change in timber markets are expected to be beneficial, increasing welfare in those markets from 2% to 8%.

Key words: climate change, dynamic optimization, integrated assessment, timber markets

Introduction

Climate change is predicted to have far-reaching effects on forests throughout the world. Ecological models predict climate change will shift the geographic distribution of tree species (Emanuel, Shugart, and Stevenson; Solomon; Shugart et al.; Neilson and Marks) and alter productivity (Melillo et al.). Despite the global nature of climate change, most analyses of timber markets have restricted themselves to single countries or regions (Binkley; Bowes and Sedjo; Joyce et al.; Burton et al.; Sohngen and Mendelsohn; McCarl et al.). While regional analysis can provide insights into how landowners and markets adjust and adapt to large-scale global climate change, regional studies cannot measure how the rest of the world responds to climate change. For instance, Joyce et al.; Sohngen and Mendelsohn; and McCarl et al. simply make assumptions about how supply will change in other regions.

A global market approach is particularly important for forestry given that climate change is predicted to affect regions very differently. For example, the ecological literature suggests high latitude forests are likely to expand deeply into the tundra, mid-high latitude forests could undergo dieback and large changes in species distribution, and low

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latitude forests are likely to increase productivity (Watson, Zinyowera, and Moss; Gitay et al.).

Despite ecological predictions that species will experience stock effects and move across the landscape, most timber market studies focus solely on future changes in forest productivity (Binkley; Joyce et al.; Perez-Garcia et al.; McCarl et al.). Perez-Garcia et al. use a global economic model, but ignore the movement of species across the landscape. Alternatively, Darwin et al. (1995, 1996) present a computable general equilibrium model of both agricultural and forestry markets. While this approach captures interdependencies among important land users, it considers only steady-state changes in forest distribution. Such an approach does not capture important intertemporal dimensions of the movement of species across the landscape, such as potential early losses of species due to dieback, and regeneration costs.

To capture the range of ecological responses, to reflect regional differences, and to capture general equilibrium price effects, it is critical that impacts be measured on a global scale. This study develops a dynamic market analysis of the impacts of climate change on global timber markets by integrating a global ecological model (Haxeltine and Prentice) with a global economic model (Sohngen, Mendelsohn, and Sedjo). The ecological model, BIOME3, is chosen because it is the only global model currently available which predicts both the shifts in species and the changes in productivity expected from climate change in a common framework. The economic model is an optimal control model, expanded from a U.S.-only study (Sohngen and Mendelsohn) to the entire globe. This is the first analysis to use this global economic model for examining the welfare impacts of climate change.

This study makes a contribution to the literature by using an optimal control model to explore how global markets may adapt to a range of ecological effects in different regions. The analysis, however, has several important limitations. First, we use only two climate scenarios and one ecological model. Consequently, we cannot present a full range of possible ecological predictions. There is considerable uncertainty about future economic, climate, and ecological conditions; readers must be careful not to interpret the scenarios as the only possible outcomes. Second, although we provide a range of dynamic outcomes, we must make some strong assumptions to derive dynamic ecological scenarios from the available equilibrium models. Third, we ignore possible shifts in the relative value of timber species with respect to one another, and instead focus on a measure of overall timber scarcity (a global timber price). Fourth, despite the importance of non-timber forest products and non-market values for forests, our analysis ignores these aspects. These important topics are ripe for future research.

Climate and Ecological Models

We use climate change predictions from two equilibrium general circulation models (GCMs). Steady-state forecasts from the Hamburg T-106 model (Claussen; Bengtsson, Botzet, and Esch) and the UIUC model (Schlesinger et al.) are used to predict changes in climate for 0.5 × 0.5 degree grid cells across the globe. The GCMs generate equilibrium global climate forecasts for current atmospheric CO_2 concentrations (340 ppmv) and for a 550 ppmv (doubling) scenario. Note that doubling refers to the effective doubling of all greenhouse gases, so that CO_2 itself is not strictly doubled in concentration. Globally, the Hamburg model predicts a 1°C increase in temperature over land and

water, while the UIUC model predicts a 3.4°C change. The Hamburg scenario predicts relatively larger temperature changes in the high latitudes compared to the UIUC scenario, while the UIUC scenario predicts larger temperature changes in the low latitudes. These regional differences suggest the two climate models will have different regional impacts on timber supply.

The climate predictions are used by a global terrestrial biosphere model (BIOME3) to estimate equilibrium changes in the distribution of timber species and the productivity of those species across the globe (Haxeltine and Prentice). Biomes are ecological types which represent accumulations of different species. We focus on the forested biomes in this study, and refer to them throughout as forest types.

While some models predict net primary productivity (see Melillo et al.) and some models predict global changes in the distribution of forest types (see Neilson and Marks), most models do not capture the two effects simultaneously. Optimizing over both effects is important because changes in net primary productivity (NPP) can affect species dominance within a forest type, and the species present can affect NPP. BIOME3 also includes carbon fertilization through the physiological effects of increased carbon dioxide on water use efficiency of plants. Based on simulations with the Hamburg climate scenario, carbon fertilization enhances the gain in NPP by 35% (Haxeltine).

BIOME3 provides more disaggregated results than the economic model can use. We aggregate the predicted effects for each contiguous forest type in BIOME3 for each region in our economic model. These aggregated effects are used to predict changes in average productivity $\theta_i(t)$, changes in forest types $\delta_i(t)$, and the area of land that can be regenerated in each timber type i in the economic model.

BIOME3 makes predictions about equilibrium outcomes. Although new ecosystem models are developing transient ecological scenarios, these models currently cover only limited regions. We consequently generate transient scenarios directly from BIOME3 making several strong assumptions.

First, we assume climate changes linearly between now and 2060, when greenhouse gases are expected to double (Houghton et al.). In 2060, we assume climate stabilizes because of an effective control program that holds greenhouse gases at 550 ppmv. This assumption allows us to solve our optimal control problem by creating a long-term steady state. By limiting the increase in greenhouse gases to doubling, we focus on the effects of emissions over the next six decades and not on emissions after 2060. Without the stabilization program, changes would continue to occur beyond 2060. Although these future effects are not likely to have a large impact on the timber market for the next half century, they will affect events by the end of the century. Second, we assume all the equilibrium ecological changes will occur proportionately over the next 60 years. That is, we assume one-sixth of the expected shifts in forest types or productivity between 2000 and 2060 will occur each decade.

Further, we assume changes in merchantable timber growth rates are proportional to predicted changes in NPP. NPP measures the net carbon stored annually by an ecosystem. We assume this ecological measure is closely correlated with the growth rate of the merchantable portion of a tree. If NPP increases by 10%, for example, we assume the merchantable part of trees in this system will grow 10% faster. This assumption implies the merchantable part of a tree remains in the same proportion to its limbs and roots and to the carbon on the forest floor. BIOME3 assumes climate change does not